BIKEABLE HOPKINTON

THE UPPER CHARLES TRAIL AND MAIN STREET

Prepared for the Hopkinton Upper Charles Trail Committee

Jordan Clark & Alex Krofta • Conway School • Spring 2015

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A BIKE-FRIENDLY MAIN STREET

TRAIL-BUILDING TOOLKIT

APPENDIX

Center Trail trailhead: where Main Street and the Upper Charles Trail meet

Background

The Upper Charles Trail is the inspiration and impetus for this study. The UCT is the vision of five Massachusetts towns to repurpose a derelict railbed as a multiuse trail, creating a 26-mile bikeable and walkable link between and through their communities. Of the five towns, Milford leads the charge with all 6.6 miles of its old railbed converted to a paved trail, drawing visitors from around the region. Holliston has completed 4.3 miles of its portion, surfacing the railbed with crushed stone. Ashland, Sherborne, and Hopkinton are hard at work on a planning and implementation process that spans decades.

As demonstrated in towns across Massachusetts, from Cape Cod to the Berkshires, regional multiuse trails provide recreational opportunities and green space to residents, deliver economic benefits and enhanced community character to towns, and strengthen the network of non-motorized connectivity between people and the places they want to be.

Main Street in Hopkinton—between the north end of the Center Trail and the Town Common—has emerged as a possible stretch of the Upper Charles Trail, following recommendations from the winter 2015 Conway report. Geographically situated at the center of the UCT's future route, it would connect to the Center Trail and head east toward Ashland. It is also the heart of town, home to centers of civic life, the local business district, gathering spaces, and the starting line of the Boston Marathon. Downtown Hopkinton is also in a state of transformation. Residents have long bemoaned the traffic (either snarled or speeding), the pedestrian experience (noisy, dangerous, and unappealing), and the lack of a unified feel along Main Street.

A major reconstruction project is in the planning stages, with town officials applying for state funding to ease traffic and improve pedestrian infrastructure along Main Street. This study plans for a bike route here as an integral part of this transformation, creating not just a link in the Upper Charles Trail but a beautiful, bikeable, and walkable downtown Hopkinton.

The Upper Charles Trail Committee in Hopkinton was given no small feat when it was charged to complete the town's portion of the UCT. A group of students from the Conway School in winter of 2015 identified various challenges to the development of the trail as a whole. Ownership of the old railbed is divided between nearly fifty private owners. Alternate routes along the railbed's path are also limited by private property, as well as terrain, wetlands, and narrow, busy roads. In 2014, however, Hopkinton completed its first stretch of the UCT—the 0.6-mile Center Trail running between the town's schools and the west end of Main Street.

The Committee has also prioritized completion of a route from Milford's completed trail to the southern end of the Center Trail. With no obvious routes yet fully available, this study maps the options through this stretch, outlining associated opportunities and challenges. It also provides a toolkit of trail-building principles, features, and costs to help planners understand and evaluate possible trail types for whatever path the future trail might eventually take.

Why Focus on Main Street?

As the center of the Hopkinton community, a pedestrian- and bike-friendly Main Street can simultaneously serve the town's efforts to revitalize downtown and complete the Upper Charles Trail.

A re-imagined Main Street could:

1. Extend the Upper Charles Trail in Hopkinton

Currently, the mile-long Center Trail, which has a trailhead on Main Street, is Hopkinton's only completed portion of the regional Upper Charles Trail. A walkable, bikeable Main Street corridor can function as a central link in this long-term trail project. In particular, a two-lane bikeway within the Main Street right-of-way can give trail users safe passage through Hopkinton's dense core without requiring the town to buy extra land.

2. Create a safe place for bicyclists

There is currently no dedicated space within the roadway for bicyclists, and all but the most fearless bicyclists avoid Main Street completely, or attempt to ride on the sidewalk, which is dangerous for pedestrians (and illegal for those over age 16). Many Hopkinton residents, moreover, say they enjoy bicycling and would welcome more opportunities to do so. A physically separate space for bikes can make Main Street both safe and comfortable for bicyclists of all ages.

3. Improve the downtown experience

Calm traffic: Residents—both pedestrians and drivers—often complain about the traffic along Main Street. Cars and trucks barrel through town or crawl with fits and starts at rush hour. Because travel lanes on Main Street are much wider than necessary (16 to 20 feet in some places), and because there are few vertical elements (such as trees) near the street to slow down drivers, speeding is effectively encouraged along much of this stretch. Installing bike accommodations on Main Street would take up space within the right-of-way, narrowing travel lanes and calming traffic. The vertical elements in the buffer zone along a bikeway, like vegetation and street lamps, would give motorists the visual cues to slow their speeds. Where these measures have been taken to calm traffic on streets similar to Hopkinton's Main Street, high speeds have been reduced, but travel time has not been appreciably increased.

Add greenery and shade: Notably missing from Main Street is the presence of a tree canopy to provide shade, color, and character to the downtown. A major construction project reconfiguring the streetscape is an opportunity to open up the pavement and add trees and other vegetation. Trees and plants along the street can significantly enhance the pedestrian experience, while also calming traffic, cleaning the air, and capturing stormwater.

Create a human-scale setting: A street designed to prioritize the automobile is inherently not scaled to the pedestrian or bicyclist. Buffers to vehicle traffic (especially trees and other vegetation), street furniture, and road narrowing can turn a thoroughfare into a comfortable place to walk, bike, and spend time. The addition of bicycle facilities to Main Street would reduce the amount of space given the automobile and increase the human domain.

Rebuilding Main Street: An opportunity for change

The Town is currently in the process of submitting plans to MassDOT for a reconstruction of Main Street. A final design must be presented to MassDOT by June 2016 for the project to receive funding and stay on schedule for construction in 2018-19. Designs have yet to be finalized, but the window to make alterations to the plan is limited. This reconstruction project presents an opportunity to use state funds to reconfigure the streetscape in a way that makes pedestrians and bicyclists more comfortable alongside automobiles.

A major reconstruction project, according to the Federal Highway Administration, is an ideal situation to add bike facilities that are inclusive of all ages and skill levels. Given MassDOT's goals of tripling the amount of walking, bicycling, and transit use in the Commonwealth by 2030, a design that improves safety, comfort, and connectivity for bicyclists (and pedestrians, as a result) on Main Street would be welcomed by MassDOT. Bicycle planning standards have undergone changes in just the past few years (toward an emphasis on physical separation of the bike facility), and the current version of a reconstruction plan for Main Street does not reflect these changes. This plan set suggests changes that the Town might include in the final design for the Main Street corridor.

Center Trail ends at Main Street, roughly a half-mile from downtown. Sidewalks are incomplete and there is no dedicated space for bicyclists, meaning trail users have limited walking/biking options beyond the trail itself.

The lack of bicycle facilities on Main Street means bicyclists must be comfortable on the street next to cars.

Many people's primary experience of Hopkinton center is the Main Street-Route 85 intersection as they pass through town. The offset intersection is the site of frequent crashes. The area surrounding this intersection is largely paved and open. Straightening the intersection and inserting trees and street furniture could improve the experience for all users.

Downtown Hopkinton is the center of civic activity, with important gathering places and local businesses in historic buildings. However, traffic is heavy, travel lanes are wide, and the pedestrian domain is marginalized.

Separated Bike Lanes Mean Inclusive Streets

Separated bicycle facilities make biking safer and more comfortable for all users of the streetscape. They are used worldwide, and are becoming the new standard in Massachusetts.

Current plans for Main Street reconstruction call for shared-road markings and paved shoulders. Is that good enough?

Paint may seem a sufficient delineator of space in plan view, but it is not enough to help most people feel comfortable riding bikes on or along busy streets. Per MassDOT, streets with speeds below 25 mph and less than 4,000 vehicles per day are generally quiet enough for bicyclists of all levels without requiring separation. Main Street far exceeds this threshold, however, with an average daily traffic count of 17,000 and actual speeds of up to 40 mph. Treating the bicycle as a part of vehicular traffic effectively excludes the majority of current and potential bicyclists (see Figure 1 below), meaning many people feel they do not have the opportunity to bike near their homes. This is reportedly the case in much of Hopkinton, and especially so on Main Street.

"Share the road:" sufficient for the average Hopkinton bicyclist?

Separated bike lanes can add to the aesthetics of a downtown (as in this Indianapolis neighborhood, left), and are inclusive of all ages and abilities of bicyclists (a typical intersection in the Netherlands, right).

This separated bike lane in Boulder, CO, uses planters and bollards to create a safe and comfortable bicycle-only route.

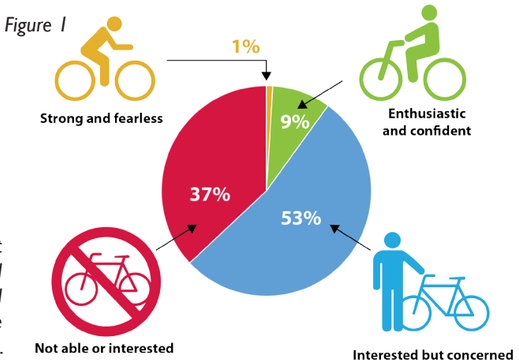
What are separated bike lanes?

Separated bike lanes are bicycle-only facilities that are physically separated from motor vehicle traffic by a vertical element, such as elevation from street level or with objects such as bollards or planters. Research has repeatedly shown that, compared to the painted-on alternative, separated bike lanes:

- *make streets safer for bicyclists, pedestrians, and drivers*
- *increase overall bicycle ridership*
- *provide a facility that is preferred by bicyclists (especially the less-experienced) and motorists alike* (Massachusetts Dept. of Transportation [MassDOT])

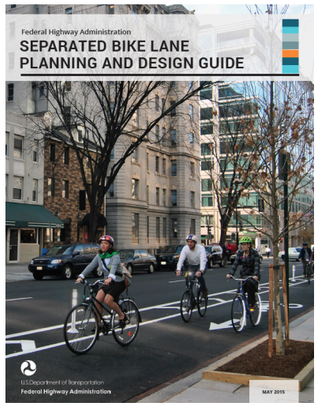
Concerns about vulnerability to automobile traffic often discourage potential (and current) bicyclists from venturing out into the streets. Exposure to faster-moving vehicles and the risk of collisions can create a stressful experience for bicyclists of any level. Separating bicycle facilities from motor vehicle traffic with a vertical element adds physical protection for the bicyclist and increases both actual and perceived safety. This also defines space for each user group—motorists, bicyclists, and pedestrians—thereby reducing conflicts, confusion, and accidents.

Figure 1



A majority of North Americans are interested in cycling, but have concerns about safety. Separated bikeways can help fill the need for a low-stress bicycle network that appeals to all ages and levels of bicyclists by providing a more comfortable space for bicyclists (Image: MassDOT).

A recently-published (May 2015) U.S. Dept. of Transportation guide to separated bike lanes aims to make streets more inclusive by advocating dedicated bicycle facilities. The guide lays out precedents and best practices. A MassDOT guide is soon to come.



Though common in Europe for decades, separated bike lanes have only begun to emerge as the preferred bicycle accommodation in North America. In an effort to reflect advances in bike facility design, the Federal Highway Administration (FHWA) released a guide for planning and designing separated bike lanes in May 2015, recommending the integration of such facilities into major reconstruction projects, particularly "as a part of a recreational, tourist, or cultural initiative" (FHWA 57).

MassDOT has also announced plans to release its own separated bike lane guide in 2015, and future street construction projects will need to provide more expansive bike facilities. This is an important step toward MassDOT's stated goal of tripling the amount of walking, bicycling, and transit use in the Commonwealth by 2030. Hopkinton has the opportunity to be on the leading edge of this shift toward more inclusive streets.

Community Character and Local Economy

People spend time in places that are pedestrian-friendly. An appealing streetscape invites visitors to shop, dine, gather with friends, and meet their neighbors. A human-scale landscape, one designed for the human being on foot, creates that type of experience. Sidewalks buffered from vehicle traffic; vehicles moving at safe speeds; and gathering spaces shaded by trees, defined by vegetation, and complimented by street furniture are among the features that contribute to human-scale space. Additionally, accessibility to these spaces via a variety of methods, including walking and biking as well as driving, increases the number and variety of people who inhabit them.

This kind of streetscape is the centerpiece of many vibrant downtowns in Massachusetts. Northampton's busy downtown has given pedestrians priority with prominent crosswalks, maintaining some street parking but concentrating lots and garages on the periphery. Lexington has seen significant economic activity in its downtown as businesses benefit from proximity to the regional Minuteman Trail, which brings thousands of visitors weekly through the town center.

Northampton, Mass., has a vibrant downtown and thriving local business scene

What are the Options for Main Street?

The recommended option for Main Street is a two-way, sidewalk-level bike path along the street's south side.

This configuration:

- provides a seamless transition for users of the Center Trail (the lone existing portion of the Upper Charles Trail in Hopkinton), and could link up with future portions of the trail;
- has fewer impacts on side streets, driveways, and on-street parking;
- requires less room within the right-of-way by consolidating buffer zones and allowing narrower bike lane widths in pinched locations;
- creates the potential for greater shade from canopy trees planted to the south;
- does not interfere with utility poles on the north side of street (if they are to remain above ground).

Raised, two-way lanes (such as this one in Indianapolis) are becoming more common in North America and Europe. They extend the "pedestrian zone" while delineating separate uses.

Motorists and pedestrians may not anticipate the contra-flow bicycle traffic (that is, bicycles moving in the opposite direction of adjacent traffic) that comes with a two-way path, but proper treatment at intersections (maintaining sightlines, using elevation/surfacing changes and signage) can minimize potential conflicts.

At the intersection with Route 85, a protected signal phase for bicycles should be used, due to the amount of traffic and the bikeway configuration. Side-street intersections can be raised or at street grade, but should clearly indicate bicycle (and pedestrian) priority. Driveway crossings should be kept at sidewalk grade, to simplify construction and minimize grade changes.

Special care also needs to be given to the points where separated bike lanes end. In this case, the westernmost part of the lane transitions to the Center Trail. At its eastern extreme, the bikeway would end at the Town Common, meaning a crossing would be necessary for any bicyclists entering town from the east. This could be incorporated into a crosswalk location. Eventually, the Upper Charles Trail may extend from the Main Street bikeway toward Ashland (and south, toward Milford), making Main Street a central feature along the regional trail.

Separation

The distinguishing feature of separated bike lanes is the vertical element between the bikeway and street. There are a number of options for achieving this vertical separation:

Street level, object or curb separated: The bikeway is at street level, buffered from the street by bollards, flexible posts (within a striped buffer zone), heavy planters, or a continuous curb. Separation with objects is common treatment on street retrofits, where full reconstruction is not an option. On-street parking can also serve the function of separation, with a proper buffer between parking and the bikeway.

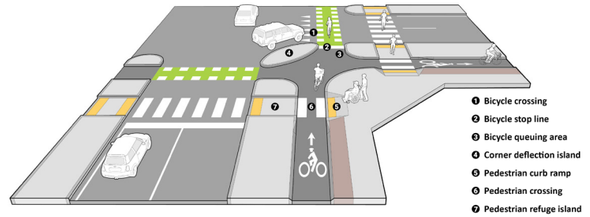
Raised: The bikeway is elevated to the same plane as the sidewalk (or to an intermediate level), separated from traffic by a curb and from the sidewalk by a street furniture strip or by continuous and clearly distinct visual delineation, such as a narrow band of unit pavers. The design should clearly designate both bicycle and pedestrian zones, to avoid clashes between users.

Intersections

Separated bike lanes not only make for a safer and more comfortable ride along busy streets, they also are designed to minimize the stress (and the hazards) of moving through an intersection. Several techniques are available to the designer, depending on the context, but they all hinge on a few key principles:

- Reducing and separating any possible ***conflict points*** (by both isolating and shielding a bicycle crossing and possibly adding a brief signal phase just for bicyclists)
- Providing adequate ***sight distance*** for all users
- Encouraging ***predictable behaviors*** and yielding (so that each user knows what to expect from the other)

Employing these principles effectively means creating a safer intersection for everyone, and requires understanding the traffic conditions at each intersection. MassDOT's forthcoming separated bike lane guide will provide extensive guidance on safe intersection design.



A MassDOT diagram illustrates intersection design elements to address vehicular traffic, bicycles, and pedestrians. Application depends on geometry, traffic patterns, and resources.

Roadway configuration

Separated bike lanes can be placed on opposite sides of the street so that each lane runs alongside traffic flowing in the same direction, or they can be joined in a two-way facility on one side (or in rare conditions, down the center) of the street.

One-way lanes may be a more intuitive addition to the roadway, since it divides directional traffic in the way that conventional (painted) bike lanes do. They may also better integrate with a community's existing roadway bicycle network. In places where bicycle facilities are new, however, the one-way lanes may inadvertently invite wrong-way bicycling

Two-way lanes are more akin to multi-use paths in joining bi-directional traffic in a single facility. In fact, they can be an effective way to transition bicyclists from a multi-use path to the roadway. They typically require less room within the right-of-way than do one-way lanes because the required buffer zone can be consolidated and individual lanes can be narrower. Additionally, a joined, two-way facility can have fewer overall impacts on driveways, intersections, and on-street parking, compared to one-way lanes on both sides of the street.

One-way separated lanes (as in Missoula, MT) divide directional bicycle traffic.

Bi-directional bike traffic can be joined into a single facility, as along this street in Washington, DC. .

Creating a human-scale streetscape

Beyond simply adding a separated bikeway to Main Street (which would confer several quality-of-life benefits on its own), the Town has the opportunity to make the street a place that draws people in and invites them to stay. This means creating a streetscape that is human scale. Since the 1950s, many American streets have become less human scale as they catered more and more to the automobile.

Downtown Nantucket, Mass.: a human-scale street

Traffic calming

Automobile traffic moving faster than about twenty miles per hour can act as a significant barrier to how pedestrians engage with destinations along a street. When the speed of traffic is lowered, pedestrians find one less reason to avoid a given street. Traffic calming implies slowing down vehicles' top speeds for a given street portion, but generally does not have an appreciable impact on overall travel time, as shown by a five-year German federal government evaluation of traffic calming measures. Narrowing travel lanes, expanding the pedestrian zone, placing trees, low vegetation, and other vertical elements like streetlights along the road edge, and maintaining on-street parking are all elements of a street designed to make drivers more aware of their surroundings and less likely to speed.

Street vegetation

Humans respond to greenery, and many Hopkinton residents chose the town specifically for its abundance of green space. Trees and other vegetation can provide shade, add color and contribute to the sense of enclosure that makes people more comfortable in their surroundings. Vegetation also helps to reduce heat island effect, captures and mitigates stormwater, provides pollinator habitat, improves air quality, and raises property values.

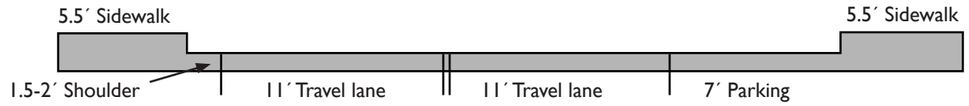
Street furniture, artwork, and interpretive elements

Practical and decorative elements for public use—from benches, bike racks, and streetlamps, to artwork and interpretive exhibits highlighting local culture and history—can add the finishing touches to a pedestrian-friendly streetscape. These elements can make the street a comfortable gathering space that reflects local identity and attracts visitors.

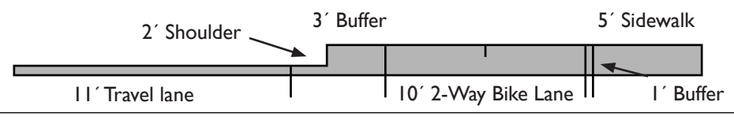
Finding Space Along Main Street for a Separated Bikeway

Making separated bikeways a reality on Main Street involves working within standard roadway criteria while also rethinking typical streetscape design that prioritizes the automobile over pedestrians and bicyclists. Along a densely developed corridor such as Main Street, it is especially important to maintain a wide pedestrian zone.

MassDOT Traffic and pedestrian criteria for Main Street



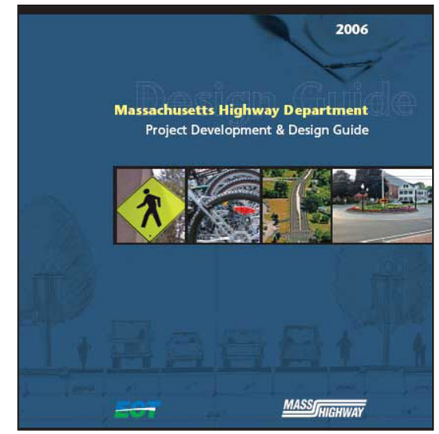
MassDOT Two-way separated bike lane criteria



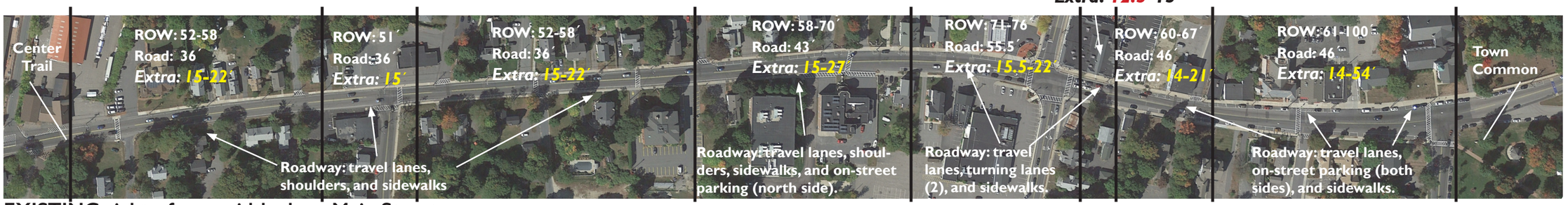
Minimum ROW width needed for bikeway: 14 ft.

Notes on roadway width criteria:

- Shoulders along turning lanes can be 1´ wide at a minimum.
- Where separate bike accommodation are not provided, minimum shoulder width is 4´.
- Bike lanes may be 8´ wide for short distances in constrained situations.
- Buffers (along roadside) may be 2´ wide for short distances in constrained situations.
- Sidewalk widths of 5.5´ include curbs.

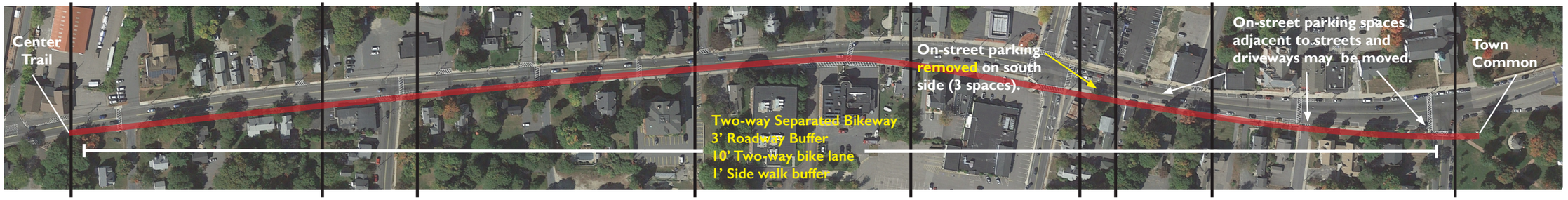


Roadway design criteria are taken from the Massachusetts Department of Transportation's (MassDOT) Project Development and Design Guide. The guide is available on MassDOT's website.



EXISTING right-of-way width along Main Street

ROW is the right-of-way width in each stretch along Main Street.
Road is the required width for the roadway elements described in the 25% Plan Resubmission. This includes sidewalks, travel lanes, turning lanes, shoulders, and on-street parking.
"Extra" is the remaining width in the ROW after accounting for all the roadway elements.



PROPOSED addition of two-way separated bikeway

1. The schematic diagram below is based on an examination of the existing roadway and the traffic changes proposed in the 25% Plan Resubmission. A detailed CAD diagram of the proposed bikeway is available in the Appendix of this report.
2. The proposed bikeway is located along the south side of Main Street to connect to the Center Trail to the west and the Town Common to the east. A two-way bikeway combined on the south side of the road reduces the number of conflicts with side streets and driveways.
3. The minimum 14´ "extra" width required for a 10´ bikeway with a 3´ roadway buffer and 1´ sidewalk buffer is available from the Center Trail to the Town Common, except immediately east of the Main St/Route 85 intersection where three on-street parking spaces can be removed to accommodate the bikeway.
4. If MassDOT determines extra sight-line distance is necessary at side streets or driveways in the downtown commercial area, additional on-street parking spots may need to be moved or removed.

Not for construction. Part of a student project and not based on a legal survey

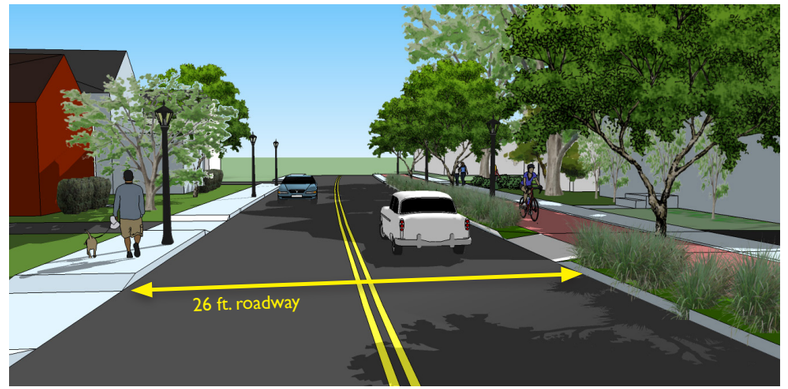
Residential Main Street, Re-imagined

A walkable, bikeable Main Street forms an extension of the Center Trail.

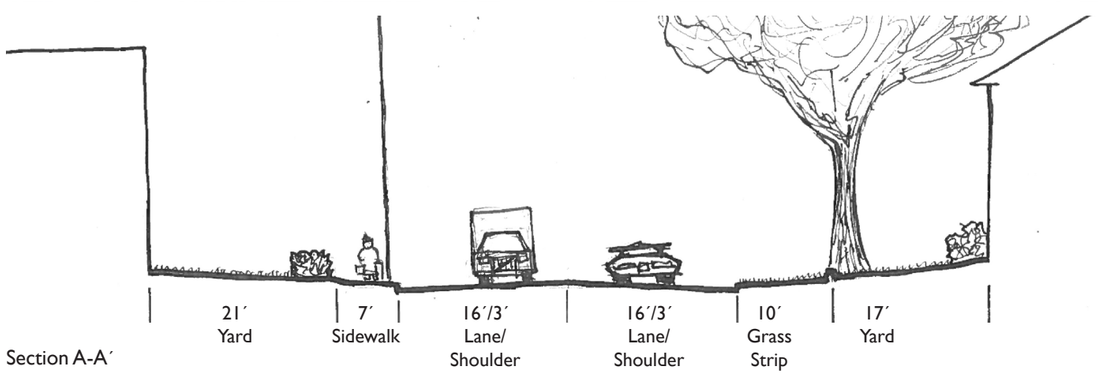
Changes to the streetscape

- A two-lane bikeway along the south side of the street creates a seamless transition from the Center Trail.
- A buffer between the bikeway and vehicle traffic (3-4') allows room for native perennial grasses, street-lamps, and possibly street trees.
- The buffer and its vertical elements create human-scale space, calm traffic, and improve the aesthetic experience for all users.
- Sidewalks (5-6') are installed on both sides of the street.
- Narrowed lanes (11' with 1.5-2' shoulders) calm through-traffic without impeding the flow of cars and trucks.
- The pedestrian zone is expanded, better defined, and separated from the roadway.
- Vegetation helps absorb runoff, improve air quality, reduce energy costs, and raise property values. Trees add shade and character to the street.

A wide road surface and incomplete sidewalks create a poor pedestrian experience.

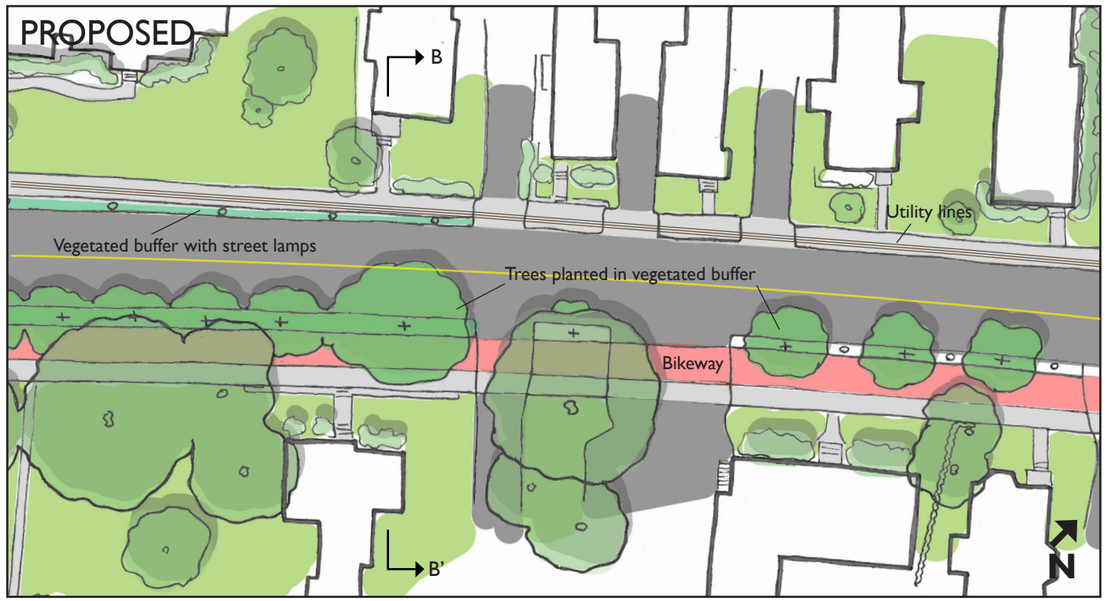


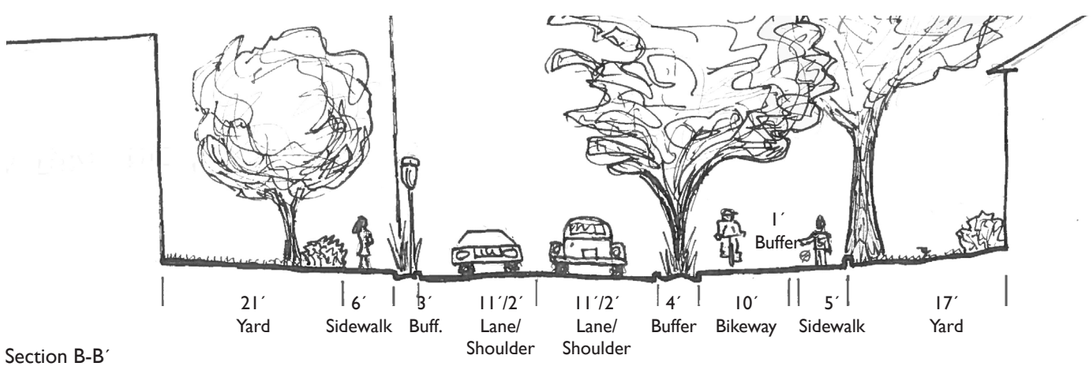
New street trees provide additional shade, and native grasses buffer the bikeway and capture stormwater.



Section A-A´

Existing streetscape is expansive, lacking in tree cover and human scale.





Section B-B´

Vegetated buffers separate pedestrians and bicyclists from the roadway and create a more comfortable gathering space.

Not for construction. Part of a student project and not based on a legal survey

Graduate Program in Sustainable Landscape Planning + Design
the ConwaySchool

BIKEABLE HOPKINTON
Jordan Clark & Alex Krofta
Spring 2015

RESIDENTIAL MAIN STREET, RE-IMAGINED

A Closer Look at Residential Main Street

Main Street becomes a bike- and pedestrian-friendly extension of the Center Trail with a raised/separated two-lane bikeway and native vegetation.

A shaded and expanded pedestrian and bicycle domain makes Main Street a more comfortable space for all users. The two-way bike lane allows residents and visitors a safer way to connect from Center Trail to downtown.

Traffic is calmed by the presence of streetside vegetation and streetlamps.

Streetside vegetation

A mosaic of native grasses and wildflowers forms a useful and colorful buffer between the pedestrian domain and the roadway. These vegetated swales retain stormwater, provide pollinator habitat, add visual texture, and make pedestrians and bicyclists feel more comfortable alongside vehicular traffic. Hardy, native species are available that can tolerate road salt, periodic inundation, and snow storage.

Front yard tree planting

Because of insufficient area within the right-of-way to include street trees along much of Main Street, the Town should consider a front-lawn tree planting program on adjacent properties. This can raise property values and help give definition to the streetscape, especially during warmer months. Philadelphia currently runs such a program citywide and expects to see a broad range of economic, environmental, and quality-of-life benefits. On the north side of the street, trees should be selected to not interfere with utility lines, should they remain.

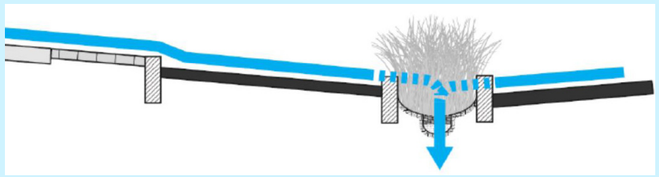
Vegetated swales buffer traffic, manage stormwater, and add color. (Photo: ryangravel.com)

The streetscape and stormwater

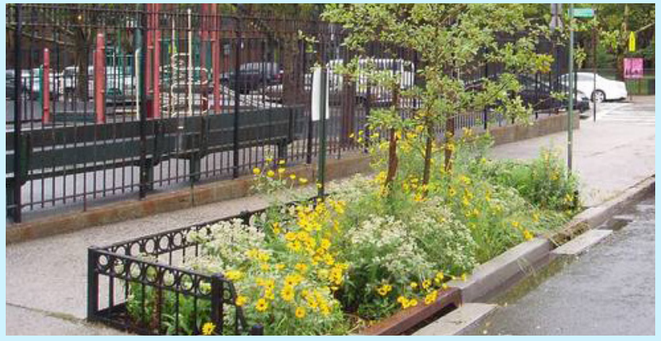
Stormwater—the rainwater and snowmelt that runs off buildings and pavement into storm drains— is a major threat to water quality. Stormwater washes pollutants and trash from the built environment into underground pipes which often discharge the untreated water into lakes, rivers, and other wetlands.

The streetscape can be changed to better manage stormwater. Impervious surfaces can be replaced with vegetation to reduce the amount of runoff, and runoff can also be diverted to green infrastructure features that use natural processes to help improve water quality.

Rain gardens are common features that use porous substrates and under-drains to infiltrate runoff into the soil. Vegetation planted in the soil helps filter out pollutants, while at the same time beautifying the streetscape.



A recessed planter strip can capture, clean, and infiltrate runoff, diverting some of it from the storm sewer system. (Image: MassDOT)



A rain garden in New York City protects water quality and adds a bit of nature to the streetscape. (Photo: NYC Environmental Protection)

Surface material should be smooth and continuous (avoid horizontal seams). Asphalt is a common surface material, but the Town may consider alternative surfacing to decrease runoff and improve soil health for trees. The bikeway should also have a distinct color to indicate its separation from both motorway and sidewalk. Special treatment in the downtown portion could be considered. Other cities have used tinted unit pavers. This can add to the aesthetics of the streetscape and communicate to the bicyclist that they are entering a different zone. Construction and maintenance costs are higher for these alternatives.

Red asphalt adds visual contrast in a Dutch neighborhood.

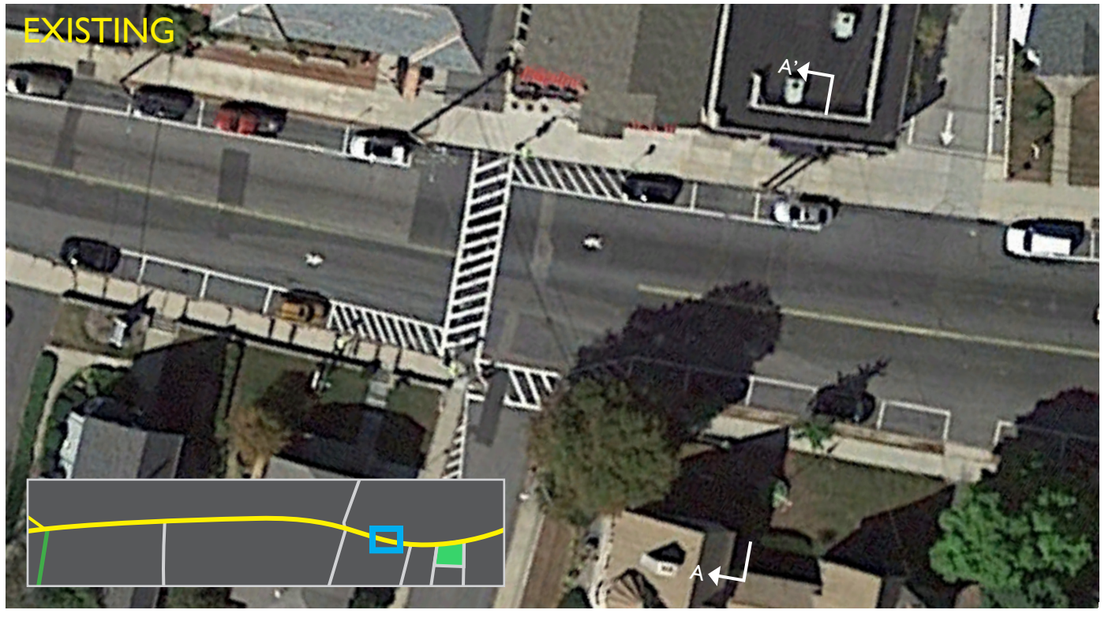
Unit pavers in a downtown setting in Indianapolis, IN.

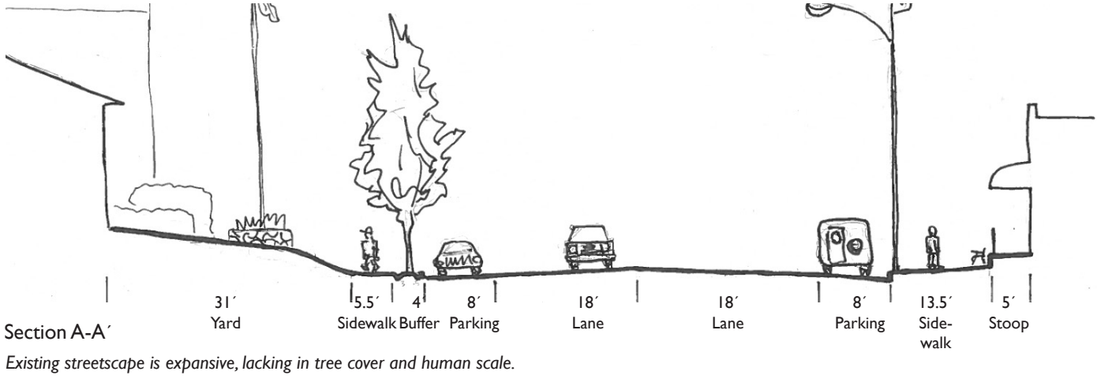
Downtown Main Street, Re-imagined

A two-way bike path and street vegetation bring new life to downtown Hopkinton.

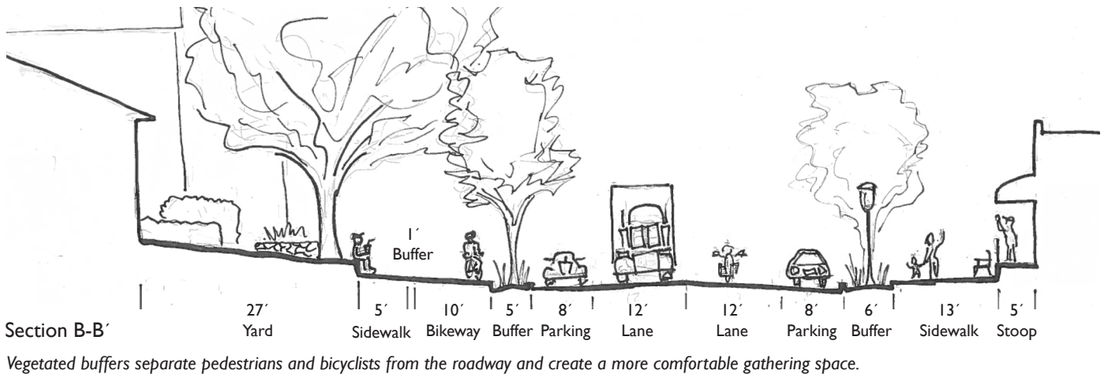
Changes to the streetscape

- The two-lane bikeway along Main Street's south side gives bicyclists easy access to the library, Town Common, local businesses, and other downtown amenities.
- Wide sidewalks allow for higher volumes of foot traffic and provide space for streetscape features such as street furniture, artwork, and outdoor cafe seating.
- Street trees add shade, give definition to both pedestrian and vehicular domains, provide ecosystem services, improve the aesthetic experience, and offer economic benefits.
- Trees planted in lawns adjacent to the sidewalk (shown with a '+' at the base) have greater soil volume to grow large and shade the street, raising property values and allowing more flexibility in the street ROW.
- The buffer and its vertical elements create human-scale space, calm traffic, and improve the aesthetic experience for all users.
- Through traffic is calmed by narrowing lanes (to 11'), adding trees and streetlamps along the street edge, and maintaining on-street parking.
- On-street parking (7 to 8' wide) serves as an extra buffer between the pedestrian/bike zone and vehicle traffic and allows drivers easy access to downtown amenities.





Existing streetscape is expansive, lacking in tree cover and human scale.



Vegetated buffers separate pedestrians and bicyclists from the roadway and create a more comfortable gathering space.

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DOWNTOWN MAIN STREET, RE-IMAGINED

A Closer Look at Downtown Main Street

The two-lane bikeway is both a centerpiece of rejuvenated downtown life and a safe, convenient way of getting there—for local residents and visitors from throughout the region.

The shaded bike path and greener pedestrian environment bring visitors by the library, local businesses, and gathering places, bringing new life to the center of Hopkinton.

A shaded and narrowed Main Street slows drivers to safe speeds, while on-street parking is retained.

Trees add character and shade in Shelburne Falls, MA. (Photo: Mass. Office of Travel & Tourism, via Flickr)

Trees are a key element in many thriving downtowns. Street trees can:

- add texture to the streetscape;
- provide much-needed shade in warmer months;
- capture and absorb rainwater;
- improve local air quality and reduce heat island effect;
- provide habitat for birds and other pollinators;
- buffer noises from the street;
- calm vehicle traffic and buffer pedestrians;;
- create a human-scale sidewalk.

Trees do well when their roots have room to grow. Where possible, tree pits should be linked, so that adjacent trees can share soil, root space, and mycorrhizae. Trees planted in such conditions grow faster and live longer than those planted in boxes with limited root space. Many municipalities have had success with trees planted under suspended pavement—where the weight of paving is supported above a void that is filled with (lightly compacted, high-quality) soil for tree root growth. Installation can be costly, however. Care should be taken to ensure that trees have enough structural soil (which can be somewhat compacted while still allowing root growth) to grow into and that root growth does not lift the bikeway.

Seasonal planters can be an effective way to add color and character to the town center, while allowing for easier snow maintenance in the winter than some permanent vegetation. They can take various forms, from large planter pots, to hanging planters, to window boxes. A management plan should ensure the plants are well tended throughout the season. This can be a community effort, where residents and businesses all contribute to beautifying the street with seasonal vegetation. It could also be maintained by a volunteer group. The Bridge of Flowers in Shelburne Falls, Mass., for example, is maintained by a local group of volunteers.

Seasonal vegetation livens up Newburyport, MA.

Separated lanes should have a maintenance plan in place for year-round use.

Maintenance is essential—especially in winter. A bikeway at sidewalk grade can be swept and cleared of snow when the sidewalk is cleared. While added elements to the streetscape, such as street furniture, trees, or artwork, may complicate some maintenance processes, they also contribute character and make the street a more pleasant and interesting place to be. Consideration should be given to the trade-offs between maintenance and streetscape.

Highlighting local culture

Public spaces often serve as the heart of a community. Incorporating artwork and local culture and history into the design of trails, parks, and streetscapes can help strengthen the connection between people and the places they share. The Clipper City Rail Trail in Newburyport, Mass., for example, features sculptures, a mural, and interpretive signage—each of which contributes to the trail's character and serves as a point of interest. Hopkinton's 2015 tricentennial, its diverse natural features (glacial erratics to native flora and fauna), and the Boston Marathon could all figure into possible interpretive elements along Main Street.

Artwork enhances the Clipper City Rail Trail in Newburyport, MA.

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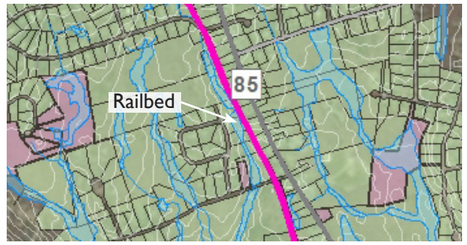
Following the Railbed through Hopkinton

Old railroad beds can be an ideal foundation for multiuse trails because they are relatively cleared, compacted, level, and connected. Fractured ownership of the railbed in Hopkinton, though, has forced the town to look for other solutions in some locations.

Divided Ownership

The six-mile stretch of the old railbed through Hopkinton is divided among 48 separate parcels, many of them privately owned. The Town owns a 1.1-mile stretch from West Main Street to the schools, which has been converted to the Center Trail —a stone dust multiuse trail popular with residents. Another .6-mile stretch of railbed running south from Granite Street towards the Milford town line, was recently purchased and may be part of a future route (see Sheets 5 and 6). Property ownership adjacent to the railbed is similarly divided: some large undeveloped parcels may provide opportunities, but numerous small residential lots remain a significant obstacle.



The railbed itself is divided among 48 separate parcels, most of them private.

Hilly, Rocky Terrain is a Challenge

When possible, using the railbed is favored because the cost and disturbance of creating a flat, stable surface through the landscape has already been done. When forced to look to surrounding areas for alternatives, certain width, slope, and curve radius criteria must be met to maintain safe conditions for trail users. These criteria complicate new trail construction. The amount of physical space needed to accommodate the width of the treadway and shoulders, the maximum trail slope for a given distance, and the minimum acceptable curve radii (or "sharpness" of a curve) increase with the steepness of the terrain.

The same rolling topography and rocky terrain that give Hopkinton its character are a challenge for creating a trail.

Wetlands are an Obstacle

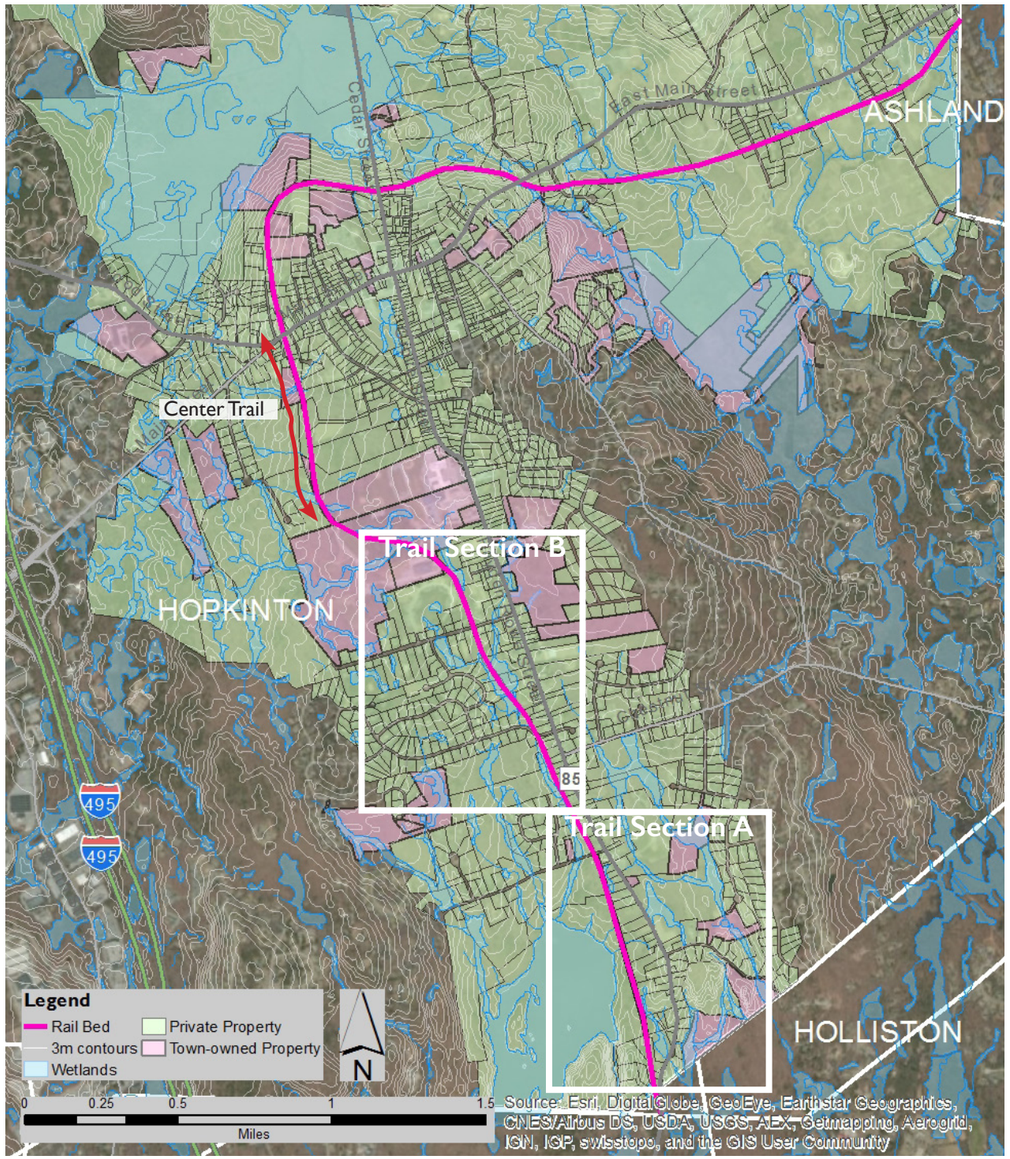
Hopkinton is criss-crossed by wetlands which are essential to wildlife habitat, flood storage, and drinking water quality. They are scenic natural features of a multiuse trail, but also present a legal, logistical, and financial challenge to trail creation. Construction along the railbed itself may fall within wetland buffers and be subject to permitting. New trail routes that pass through wetlands will require permitting, as well as the engineering and construction expense to create a safe and beautiful trail experience while also protecting habitat and maintaining wetland function.

Streams and wetlands necessitate permitting and crossing structures, but also provide scenic natural features for trail users.

Narrow Roads and High Speeds

Bike travel is legally permitted on all Massachusetts roads (except for interstates). Roads, like the railbed, are already flat and firmly surfaced, and therefore may be viable for siting portions of a trail where other options do not exist. Traffic speeds and roadway width, however, are key to the safety and comfort of trail users. Some roadways could be used as a permanent or temporary link with little modification; some would require extensive reconfiguration of the streetscape; and some may not have sufficient space within the legal Right of Way (ROW) to allow bike routes that would be (or be perceived as) safe for users.

Narrow roads with fast-moving vehicles like Hayden Rowe Street, make for dangerous cycling on streets. (Google Maps)



Moving forward, without an obvious route...

Prioritizing Sections and Zooming In

The Upper Charles Trail Committee has identified finding a route between the Milford trail and Granite Street (Trail Section A) and Granite Street and the Center Trail on Loop Road (Trail Section B) as priorities. Sheets 10 and 11 provide maps showing possible routes in these sections and describe opportunities and challenges along them.

Considering Implementation

Sheets 12-14 provide a "toolkit" that can be used by planners to evaluate different route options based on the associated features and costs. Since the actual route is unknown, the toolkit uses three examples typical to many other locations in Hopkinton.

Trail Section A:
Milford to Granite Street

Linking to Milford's section of the Upper Charles Trail will improve regional connectivity, and allow users to continue into Hopkinton.

Milford's trail section is completed and paved, drawing visitors from around the region. The UCTC has identified as a priority connecting to this trailhead just over the town line.

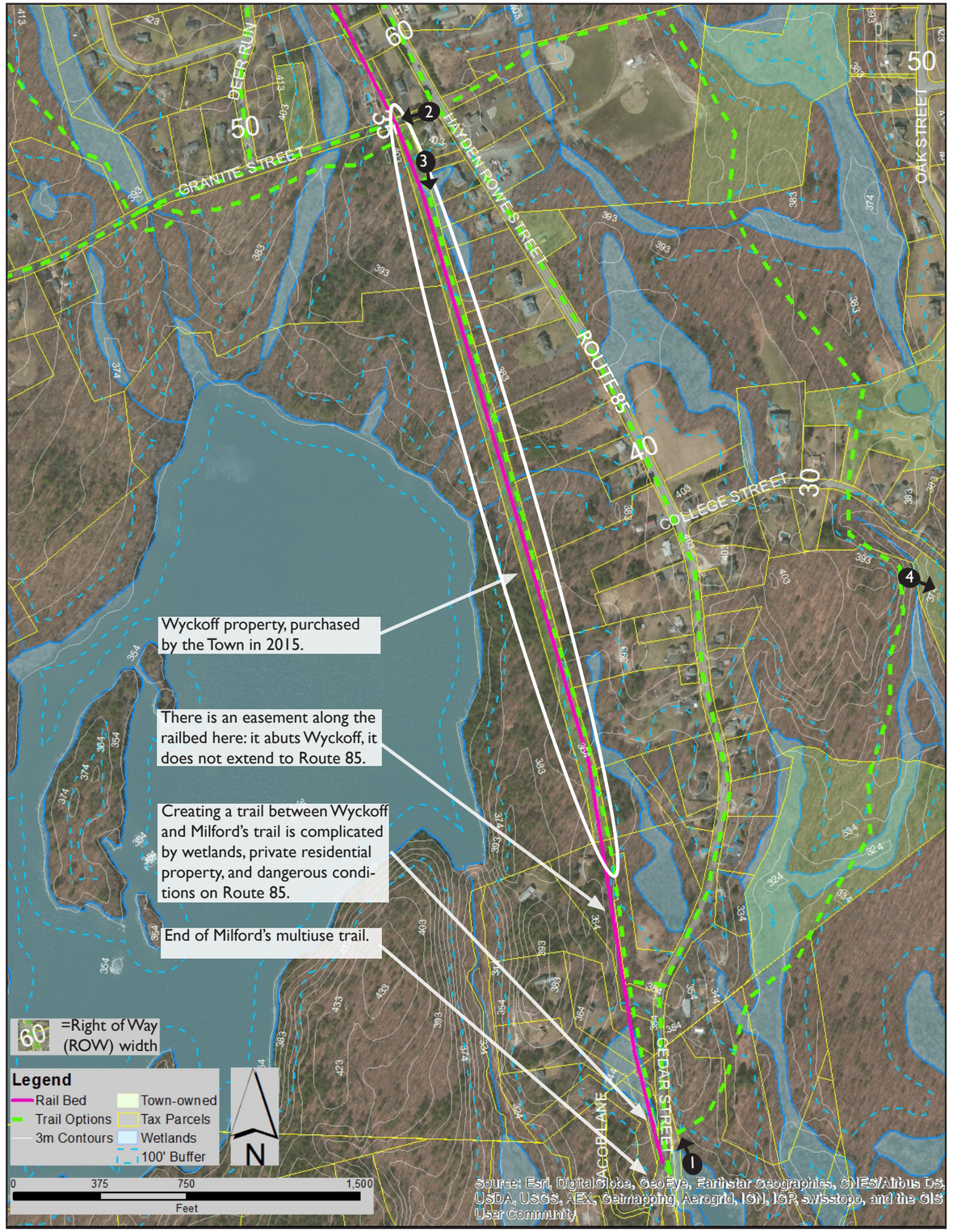
Despite the short geographic distance, challenges in this stretch are considerable. Identified here are potential routes from the Milford trailhead to Granite Street, and some of the opportunities and challenges facing each.

Getting from the Milford trailhead through Hopkinton is a challenge, due to property ownership along the old railbed and traffic along Route 85.

Granite Street and Hayden Rowe Street are narrow with high vehicle speeds. Safe and comfortable bike lanes would require expanding the road shoulders or acquiring rights to adjacent properties.

Hopkinton recently purchased the Wyckoff property, which contains .6 miles of the old railbed running from Granite Street south toward—but not connecting to—the Milford multiuse trailhead.

A route to the east of Hayden Rowe Street would require extensive excavation and grading, in addition to property acquisition. It could, however, pass by College Rock, a popular recreational resource.



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SECTION A: MILFORD TO GRANITE STREET

Trail Section B: Granite Street to Center Trail

A bikeable link in this area would connect users to Main Street via the Center Trail, which begins at Loop Road west of the town's schools.

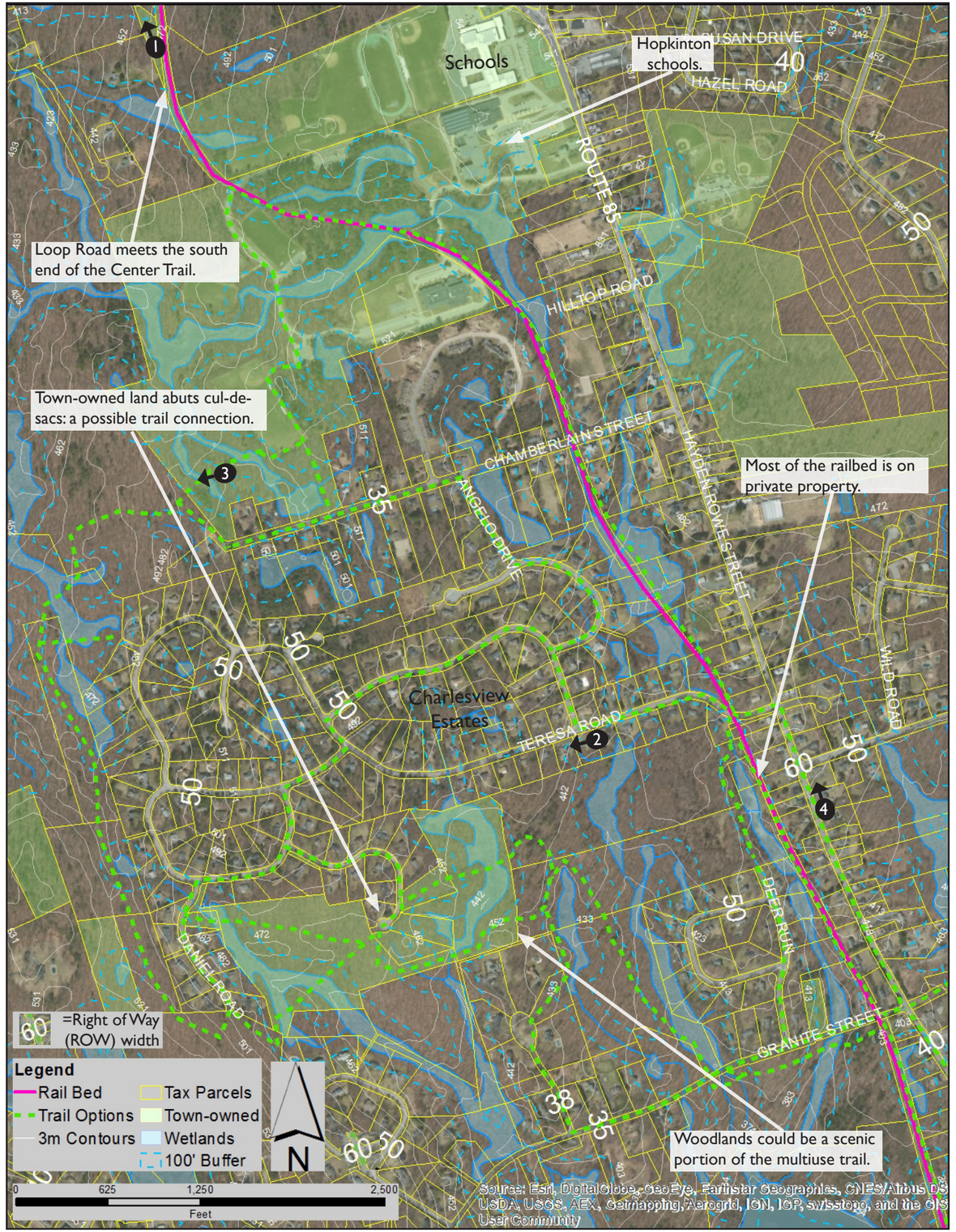
Hopkinton's Center Trail is a stone dust multiuse trail completed in 2014. At the north end is Main Street, and to the south are the schools and residential neighborhoods. Continuing a bikeable route south of the Center Trail would expand recreational opportunities to residents in this area and provide bike and pedestrian access into the town center.

The future multiuse trail will use the Center Trail as a part of the future route. It is a already a frequently used recreational resource in Hopkinton.

Nearly 200 homes line the streets of Charlesview Estates. Low speeds and road surface widths of 26-28' could accommodate a portion of the trail route.

A new trail through woodlands would create access to natural areas, but would be costly to complete due to wetlands and topography.

Despite its prime location linking Main Street and Milford's trail, Hayden Rowe (Route 85) is a challenging option due to its high volume, speed (40 MPH), and surface width of just 22'.



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SECTION B: GRANITE STREET TO CENTER TRAIL

Trail Toolkit:
Using the Railbed

The multiuse trail will likely use the old railbed whenever possible due to its relatively cleared, compacted, and level surface. Looking at a typical portion of the existing railbed, this study allows planners to think about design principles, possible elements, and costs.
The future trail may utilize this route or others that are similar.

Factors to Consider for Using the Railbed

This section of the railbed at the Wyckoff property has some debris and vegetation, and is at a level grade with the surrounding terrain.

Physical Condition: Railbeds are repurposed as multiuse trails because they are level, cleared of vegetation, compacted, and maintain safe grades along their length. After decades of use (and disuse, or misuse), some areas may require extra rehabilitation. Vegetation and debris must be cleared and uneven surfaces must be leveled. If width is insufficient, fill may be needed to build up the edges of the railbed.

Side Slopes: Steep grades (greater than 1:3, or 33%) and other hazards along the railbed require barrier fences. In places where the railbed was raised above the surrounding landscape, this will likely be a necessary component.

Type of Surface: Asphalt surfacing is expensive, but makes a wider array of uses possible. Asphalt also, unfortunately, contains a number of toxic substances. A stone dust surface is cost effective and allows for hiking and biking, and is wheelchair accessible. It also has a rustic, natural aesthetic.

A section of the railbed crossing a beaver pond east of downtown Hopkinton is clear and level, but flanked by steep slopes.

Signs: Entrances to the trail may require signs to direct and inform users. Along the trail, private property notifications can help reduce conflicts. A multiuse trail is also an opportunity to use signs to educate users about local ecology and history.

Vehicles: Preventing illegal motorized vehicles is essential for user safety as well as for preserving the trail surface. Removable bollards or another gate structure can accomplish this task while still allowing maintenance and emergency vehicle access.

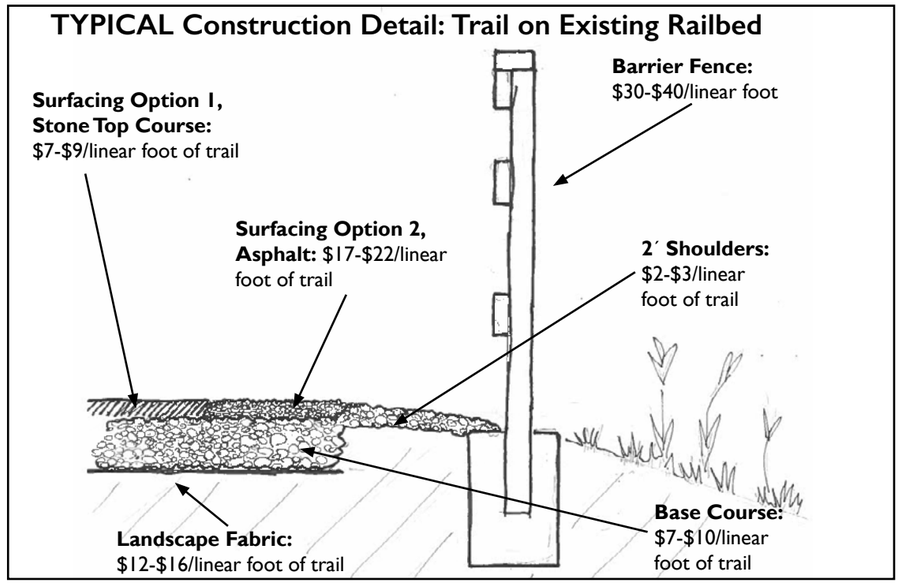
Construction Access: Trail building involves a good deal of labor, materials, and equipment, so getting to and from a site can have significant impact on project cost. Road access, staging areas, and other logistical factors will be important.

Wetlands: The railbed passes through wetlands and wetland buffers, but permitting is likely to be less involved since the majority of the earth-moving, clearing, and other disturbance was previously done by the railroad company.

Example Route:
1/2 Mile on the Existing Railbed

- Connects to Granite Street
- Uses a portion of the railbed under town ownership
- Passes within Bordering Vegetated Wetland 100´ buffers, requiring permitting
- Crosses wetlands in pre-existing culverts, limiting disturbance and permitting

TYPICAL Construction Detail: Trail on Existing Railbed



Improved Trail on Existing Railbed: 1/2 Mile - 16' Width (12' Trail w/ 2' Shoulders)

Element/Item	Unit	Unit Cost, $ (low)	Unit Cost, $ (high)	Quantity	Cost, $ (low)	Cost, $ (high)	Description
Clearing and Grubbing	acre	5,000.00	8,000.00	1	5,000.00	8,000.00	Clear and remove vegetation, soil, and debris from the surface of the railbed.
Grading	square foot	0.20	0.40	44000	8,800.00	17,600.00	Creates a level, even surface for the trail.
Fill	cubic yard	10.00	20.00				**Possible:** fill may be needed where existing railbed width is insufficient.
Landscape Fabric	square yard	9.00	12.00				**Possible:** may be needed to prevent base course settling on soft native soil.
12' Crushed Stone Base Course (1-2: diameter, 6" depth)	ton	40.00	55.00	500	20,000.00	27,500.00	Support and leveling for the treadway.
2' Crushed Stone Shoulder x2 (1-2" diameter, 2" depth)	ton	40.00	55.00	125	5,000.00	6,875.00	Drainage and "recovery area" for trail users.
12' Crushed Stone Top Course (1/4 minus stone, 2" depth)	ton	50.00	65.00	350	17,500.00	22,750.00	Surface treatment for the treadway (Option 1).
Ashpalt Surface (2" depth)	ton	100.00	130.00	450	45,000.00	58,500.00	Surface treatment for the treadway (Option 2).
Barrier Fence	linear foot	30.00	40.00				**Possible:** 3-4' barrier fence needed along hazardous side slopes. Wood with cement footings, 3-4' height.
Entrance Sign	each	350.00	500.00	1	350.00	500.00	Entrance sign at Granite Street Entrance, similar to Center Trail sign on W. Main St.
Entrance Sign	each	75.00	125.00	5	375.00	625.00	Trail markers and "No Tresspassing" for adjacent private property. Metal.
Entrance Sign	each	500.00	1,200.00	2	1,000.00	2,400.00	Prohibit illicit vehicle entry and allow emergency/maintenance vehicles.
Entrance Sign	acre	3,500.00	5,000.00	0.4	1,400.00	2,000.00	Restoration of disturbed areas along construction zone.
Entrance Sign	lump sum	4.00	6.00	600	2,400.00	3,600.00	Prevent construction erosion from running off into wetland areas.

Mobilization	3-5%	1,854.75	4,592.50	2,679.75	6,380.00
Construction Survey	1.5-2.5%	927.38	2,296.25	1,339.88	3,190.00
Design and Administration	15-20%	9,273.75	18,370.00	13,398.75	25,520.00
Wetland Permitting (3	$5000 each	15,000.00	1,500.00	15,000.00	15,000.00
Taxes	6.25%	5,555.05	7,413.05	7,608.96	11,105.63
Contingency	10-12%	11,332.31	15,122.62	12,935.23	22,655.48

		Low Cost, $	High Cost, $		Low Cost, $	High Cost, $
Grand Total	**Stone Surface**	**105,768.24**	**141,144.41**	**Asphalt**	**142,287.57**	**211,451.10**
	cost of 12' wide trail per linear foot, $	40.06	53.46	cost of 12' wide trail per linear foot, $	53.90	80.10

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Trail Toolkit:
Blazing a New Trail

A new section of trail through the woods can be a costly endeavor but also can create a scenic experience and allows access to natural areas. Described here is a typical portion of a newly-constructed route through a woodland, to enable planners to think about design principles, possible elements, and costs.
The future trail may utilize this route or others that are similar.

Factors to Consider for New Trail Construction

Excavation: Creating a new trail requires excavating a swath through the landscape. Trees, boulders, and debris must be removed. Topsoil must be scraped and a base course of crushed stone installed to create a firm, even treadway. Site conditions will determine the extent of the work needed. Open areas, flat topography, or a preexisting trail may require less effort to install a trail.

A Safe Ride: A multiuse trail is not as simple to construct as a hiking trail. To be safe for bike riders, it must meet specific width, grade, and curve dimensions described in the table to the right. These dimensions mean that installing a trail on steep hill (more change in vertical elevation) will require a longer trail (horizontal length) across the stretch. It may be helpful to imagine a switchback descending a mountain side; also remember that hairpin turns may not be suitable for cyclists coming off a steep grade. The longer the trail, the more excavation and construction will be needed, increasing project costs.

A hilly, rocky woodland east of the Center School in downtown Hopkinton is a challenge for building a new trail.

Surface, Signs, and Access: Many of the same considerations facing a trail on the railbed apply to a new trail. These elements are described on the previous sheet.

Disturbance: Excavating a new trail will create significantly more disturbance to the landscape than using the railbed. Erosion control measures and reseeding disturbed areas will be required for both types, but will be more involved for a new trail.

An existing foot trail around Charlesview Estates may be an easier route.

Wetlands: Earth-moving, clearing, and construction within wetlands or buffers will require more extensive permitting in undisturbed areas than on the existing railbed. Wetland boardwalks are expensive to engineer and build, and must meet standards for resource protection laid out be the Massachusetts Wetland Protection Act. In some cases, disturbed wetland areas will need to be "replicated" as part of the permitting process.

A wetland boardwalk at Trap Pond State Park, in Laurel, DE. (photo: Delaware Dept of Natural Resources and Environmental Control Division of Parks and Recreation)

Design criteria from "Chapter 11 - Shared Use Path and Greenways" of MassDOT's Project Development and Design Guide

Exhibit 11-2
Shared Use Path Dimensions

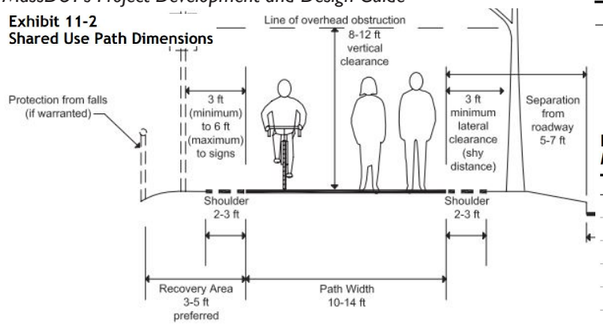


Exhibit 11-5
Minimum Curve Radii

Design Speed (mph)	Minimum Radius (feet)
12	36
15	56
20	100
25	156
30	225

Exhibit 11-7
Maximum Grade Lengths for Bicycles

Grade (%)	Maximum Length (ft)
5 to 6	800
7	400
8	300
9	200
10	100
11+	50

Engineering Guidelines for a Multiuse Trail

Design of a new multiuse trail must take into account the **width** of the treadway and the shoulders to allow for safe travel.

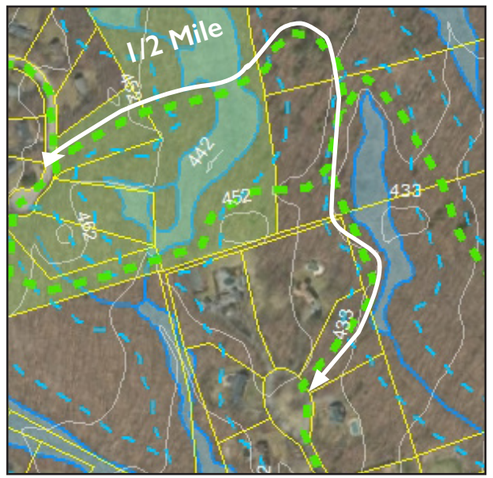
The **radius of curves** is critical to avoid overly-sharp, dangerous turns. Higher travel speeds require wider turns, which increase the amount of total area needed to create a trail on steep terrain.

Grades and **grade lengths** are very important to a safe multiuse trail. Maximum grades —and the maximum length for any given grade— are specified above. Steeper grades are acceptable for much shorter distances, so a trail will need to "wind" down any steep hills, requiring an longer overall trail length, and therefore more construction.

Wetland crossings will require boardwalks, an attractive but expensive feature of a multiuse trail. Information regarding Hopkinton's bylaws and the Massachusetts Wetland Protection Act permitting information is available on the town's website.

Example Route: 1/2 Mile of New Trail Construction

- Connects two roadways
- Crosses town-owned land, and some private land that may require purchase or easements
- Maintains acceptable grades and grade distances
- Crosses a 100´ wetland buffer
- Crosses a wetland



New Trail Construction: 1/2 Mile - 16' Width (12' Trail w/ 2' Shoulders)

Element/Item	Unit	Unit Cost, $ (low)	Unit Cost, $ (high)	Quantity	Cost, $ (low)	Cost, $ (high)	Description
Excavation	cubic yard	20.00	30.00	1200	24,000.00	36,000.00	Prepare a bed for laying base course.
Clearing and Grubbing	acre	5,000.00	8,000.00	1	5,000.00	8,000.00	Clear and remove vegetation, soil, and debris.
Grading	square foot	0.20	0.40	44000	8,800.00	17,600.00	Creates a level, even surface for the trail.
Fill	cubic yard	10.00	20.00				Possible: fill may be needed where existing railbed width is insufficient.
Landscape Fabric	square yard	9.00	12.00				Possible: may be needed to prevent base course settling on soft native soil.
12' Crushed Stone Base Course (1-2" diameter, 6" depth)	ton	40.00	55.00	500	20,000.00	27,500.00	Support and leveling for the treadway.
2' Crushed Stone Shoulder x2 (1-2" diameter, 2" depth)	ton	40.00	55.00	125	5,000.00	6,875.00	Drainage and "recovery area" for trail users.
12' Crushed Stone Top Course (1/4 minus stone, 2" depth)	ton	50.00	65.00	350	17,500.00	22,750.00	Surface treatment for the treadway (Option 1).
Ashpalt Surface (2" depth)	ton	100.00	130.00	450	45,000.00	58,500.00	Surface treatment for the treadway (Option 2).
Barrier Fence	linear foot	30.00	400.00				**Possible:** barrier fence needed along hazardous side slopes. Wood with cement footings, 3-4' height.
Entrance Sign	each	350.00	500.00	2	700.00	1,000.00	Entrance sign at Granite Street Entrance, similar to Center Trail sign on W. Main St.
Trail Signs	each	75.00	125.00	6	450.00	750.00	Trail markers and "No Tresspassing" for adjacent private property. Metal.
Removable Bollards	each	500.00	1,200.00	4	2,000.00	4,800.00	Prohibit illicit vehicle entry and allow emergency/maintenance vehicles.
Seeding/Groundcover	acre	3,500.00	5,000.00	0.4	1,400.00	2,000.00	Restoration of disturbed areas along construction zone.
Wetland Boardwalk (10' width)	linear foot	500.00	800.00	125	62,500.00	100,000.00	Boardwalk crossing wetland. Wood with footings, railing.
Erosion Control	linear foot	4.00	6.00	1000	4,000.00	6,000.00	Prevent construction erosion from running off into adjacent areas.

Mobilization	3-5%	4,540.50	11,663.75		4,645.50	11,651.25
Construction Survey	1.5-2.5%	2,270.25	5,831.88		2,682.75	6,725.63
Design and Administration	15-20%	22,702.50	46,655.00		26,827.50	53,805.00
Wetland Permitting (1 buffer, 1 wetland)	$5000, $20000	25,000.00	25,000.00		25,000.00	25,000.00
Taxes	6.25%	12,866.45	20,151.60		14,875.36	22,887.93
Contingency	10-12%	26,247.56	41,109.27		25,288.11	46,691.38
		Low Cost, $	High Cost, $		Low Cost, $	High Cost, $
Grand Total	**Stone Surface**	**244,977.27**	**383,686.49**	**Asphalt**	**278,169.22**	**435,786.18**
	cost of 12' wide trail per linear foot, $	92.79	145.34	cost of 12' wide trail per linear foot, $	105.37	165.07

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Trail Toolkit:
Along a Roadway

Using existing roadways as a link between the railbed or woodland portions of the multiuse trail can be a cost-effective strategy when other routes prove unfeasible due to ownership, costs, topography, or wetlands. Described here is typical route through a residential neighborhood, to illustrate design principles, possible elements, and costs.
The future trail may utilize this route or others that are similar.

Deer Run, a quiet side street, has a 60´ ROW, 26´paved road surface, slow traffic, and a sidewalk. Travel lanes (9´) and bikeable shoulders (4´) could be accommodated here.

Factors to Consider on Roadways

Right of Way (ROW): The ROW is land owned by a town, county, or state that contains roadways for vehicles, bicycles, and pedestrians; utilities like sewers and power lines; and the space adjacent to these facilities. The width of the ROW along Hopkinton's roadways represents the space available to provide bike accommodations. The width of the ROW is variable.

Road Surface Width: The road surface rarely fills the entire ROW. Paved surface widths are also variable. Wide roads may include shoulders used by cyclists, or can be retrofitted with bike lanes and shoulder stripes if space is sufficient.

Travel Lanes: The minimum travel lane width varies according to road type. Local roads can have 9-12´ lanes, while collectors 10-12´, and arterial routes 11-12.´

Bike Accommodations: Bike riders are legally allowed on roadways (except interstates) and are required to follow the rules of the road as though they were motorists. Shoulder stripes can be used to help define the space available to cyclists, and a 4-5´ shoulder is the preferred width (though narrower shoulders may be acceptable, especially with lower vehicle speeds). Dedicated bike lanes further increase clarity and safety for all users, but may not be necessary (low speeds and volumes) or feasible (insufficient ROW) in all cases.

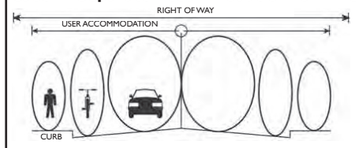
Sidewalks: Sidewalks are an important streetscape feature, especially in areas of high traffic speeds, high traffic volume, and lots of pedestrian activity. The preferred width for a sidewalk is 5´ with a 6´´ curb. It is, however, illegal for cyclists over the age of 16 to ride on the sidewalk, and bike accommodations should be separate from pedestrian accommodations.

Traffic Speeds and Volumes: Appropriate bike accommodations are directly related to the speed and volume of traffic on the road: put simply, more and faster traffic requires more separation between bikes and cars. The diagram at top right describes typical scenarios.

Granite St. has a 35´ ROW, 22´paved road surface, high speeds and no sidewalks. Bikeable shoulders would be only 2´ here.

Exhibit 5-6
Summary of Multi-modal Accommodation Options

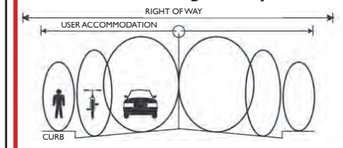
Case 1: Separate Accommodation for All Users



- Often the preferred option to provide safe, convenient, and comfortable travel for all users.
- Appropriate for areas with moderate to high levels of pedestrian and bicycle activity.
- Appropriate for roadways with moderate to high motor vehicle speeds.
- Appropriate in areas without substantial environmental or right-of-way constraints.

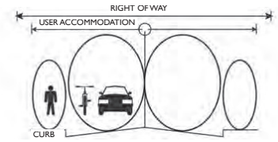
Example Route type

Case 2: Partial Sharing for Bicycles and Motor Vehicles



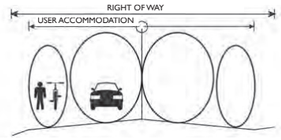
- Used in areas where the width necessary to provide Case 1 accommodation is not available.
- Under Case 2, pedestrians are provided with a sidewalk or separate path while space for bicyclists and drivers overlap somewhat.
- Appropriate in areas with low motor vehicle speeds and low to moderate motor vehicle volumes.

Case 3: Shared Bicycle/Motor Vehicle Accommodation



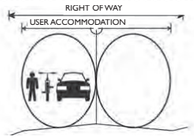
- Under Case 3, pedestrians remain separate but bicycle and motor vehicle space is shared.
- Used in densely developed areas where right-of-way is constrained.
- Also applicable to most residential/local streets where speeds and traffic volumes are low.

Case 4: Shared Bicycle/Pedestrian Accommodation



- Under Case 4, pedestrians and bicyclists share the shoulder.
- Common in rural or sparsely developed areas.
- Appropriate for areas with infrequent pedestrian and bicycle use.

Case 5: Shared Accommodation for All Users



- Under Case 5, all users share the roadway.
- Appropriate where user demands and motor vehicle speeds are very low or when severe constraints limit the feasibility of providing separate accommodation.

Diagram from "Chapter 5 - Cross-section and Roadside Elements" of MassDOT's Project Development and Design Guide

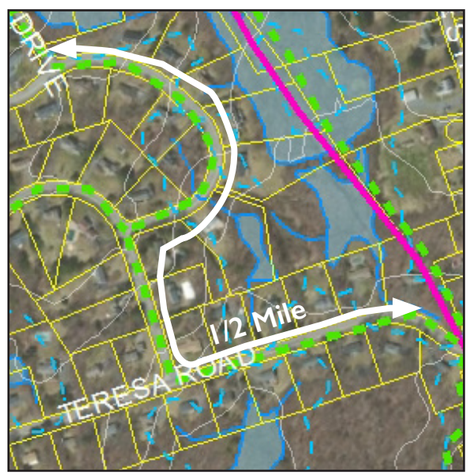
Guidelines for Bicycles on the Roadway

The Example Route described here falls under the Case 2 scenario. Described alongside the diagram are the conditions under which such a configuration is appropriate.

Taken from the Massachusetts Department of Transportation (MassDOT)'s award winning *Project Development and Design Guide*, the diagram above can be used in planning a network of bikeable routes throughout Hopkinton. The *Guide* is available for free download on MassDOT's website.

Example Route:
1/2 Mile on Existing Roadway

- 50-60´ Right-of-Way
- 28´ road surface
- Separated sidewalk in many locations provide separate pedestrian accommodations
- Signs direct users along the roadway to formal sections of the trail
- Painted stripes define 4´ shoulders where bicycles are legally permitted to ride



An imagined stretch of Teresa Road with retrofitted bike accommodations. Benefits:

- **Lower cost** than off-road route options.
- **Quick installation** due to town ownership and ease of planning and implementation
- **Easy access** for people living along the route, increasing usership
- **Temporary link** during planning stages of other trail sections
- **Permanent neighborhood feature** improving bikeability

Residential Road: 1/2 Mile Connecting Route

Element/Item	Unit	Unit Cost, $ (low)	Unit Cost, $ (high)	quantity needed	Cost $, (low)	Cost $ (high)	Description
Shoulder Striping (both sides)	linear foot	1.50	2.00	5500	8,250.00	11,000.00	Painted lines indicate 4' shoulders for cyclists.
Trail Signs	each	200.00	300.00	10	2,000.00	3,000.00	Metal signs and posts: "Bike Trail - This Way" to direct users.

		Low Cost, $	High Cost, $
Grand Total		**10,250.00**	**14,000.00**
	cost of trail per linear foot, $	3.88	5.30

Preliminary CAD drawings of proposed two-way separated bikeway

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- Drawings depict roadway elements within the horizontal width of the legal Right of Way.
- Drawings do not depict intersections in detail.
- Drawings do not depict proposed vegetation.
- All alignments should be verified in the field.
- The final design of Main Street to be set by a licensed engineer.
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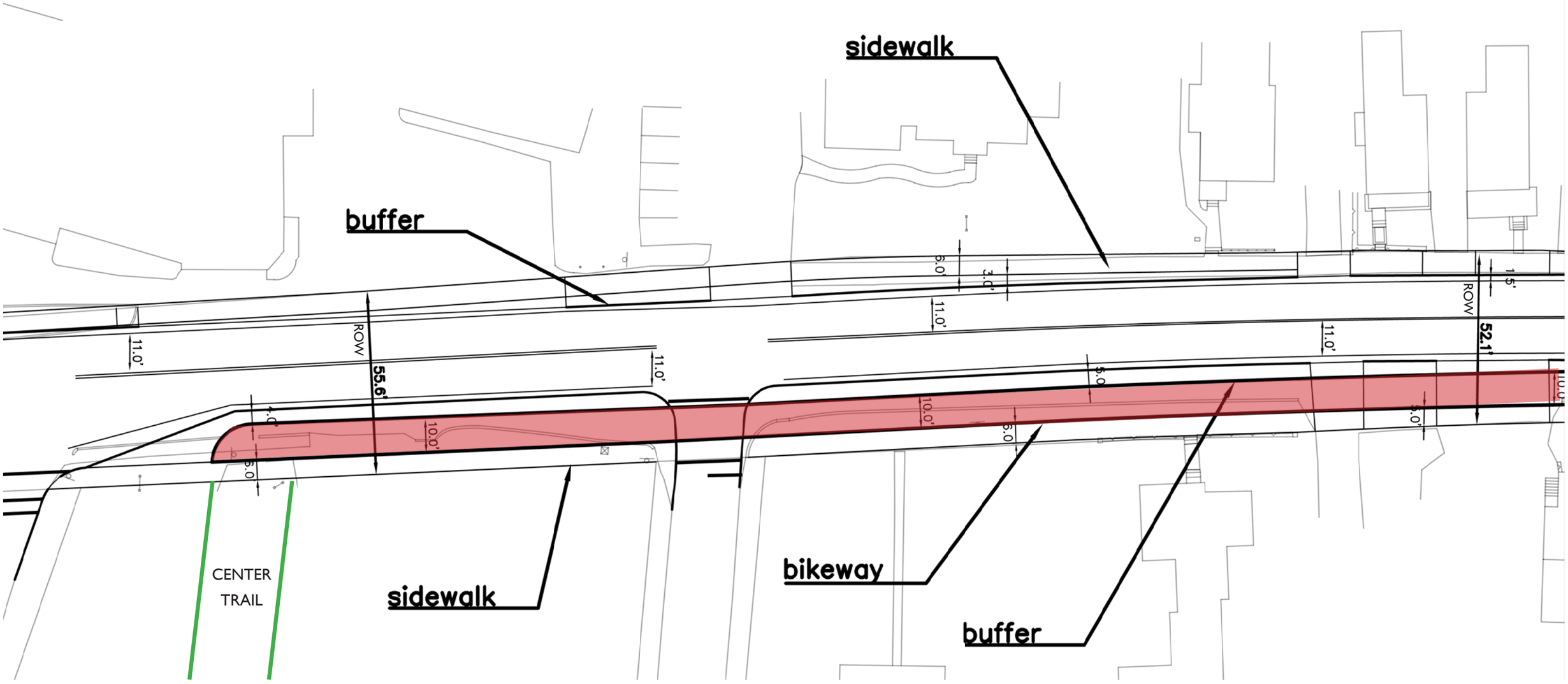
Key plan N.T.S.



Proposed Two-way Separated Bikeway
Scale: 1" = 30'-0"

1

APPENDIX: Preliminary CAD Drawings of Proposed Two-lane Bikeway
BIKEABLE HOPKINTON
Main Street, Hopkinton, MA
Jordan Clark & Alex Krofta | Spring 2015

the **Conway**School
Graduate Program in Sustainable Landscape Planning + Design

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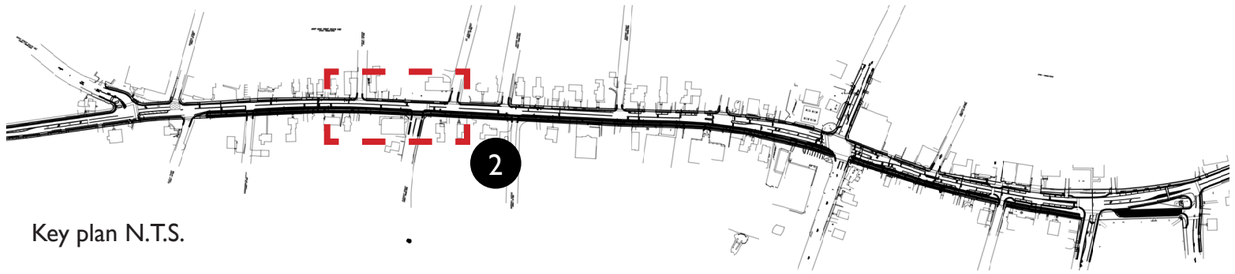

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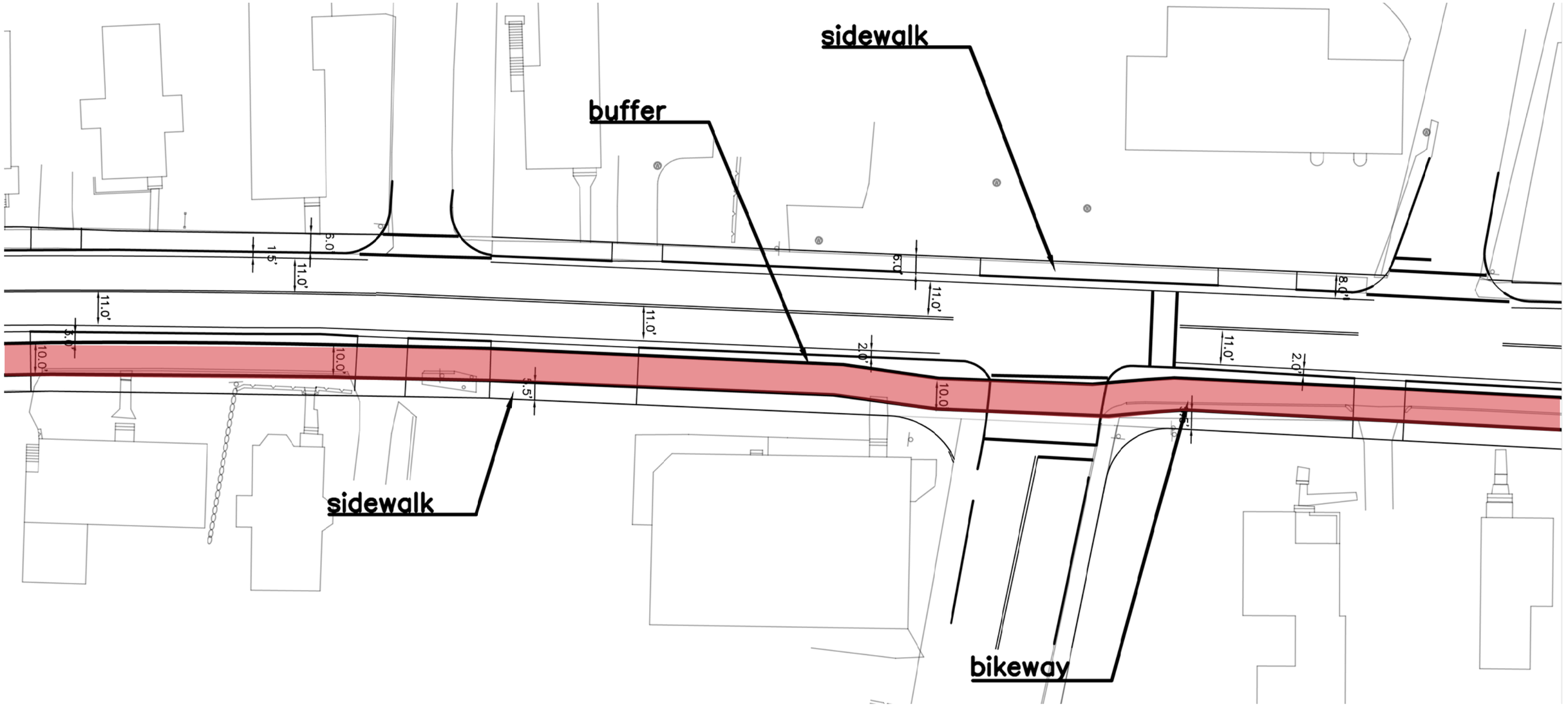

Proposed Two-way Separated Bikeway 2
Scale: 1" = 30'-0"

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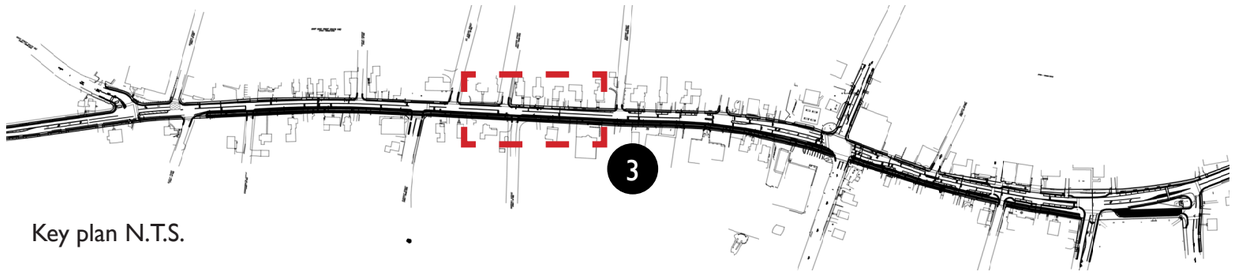

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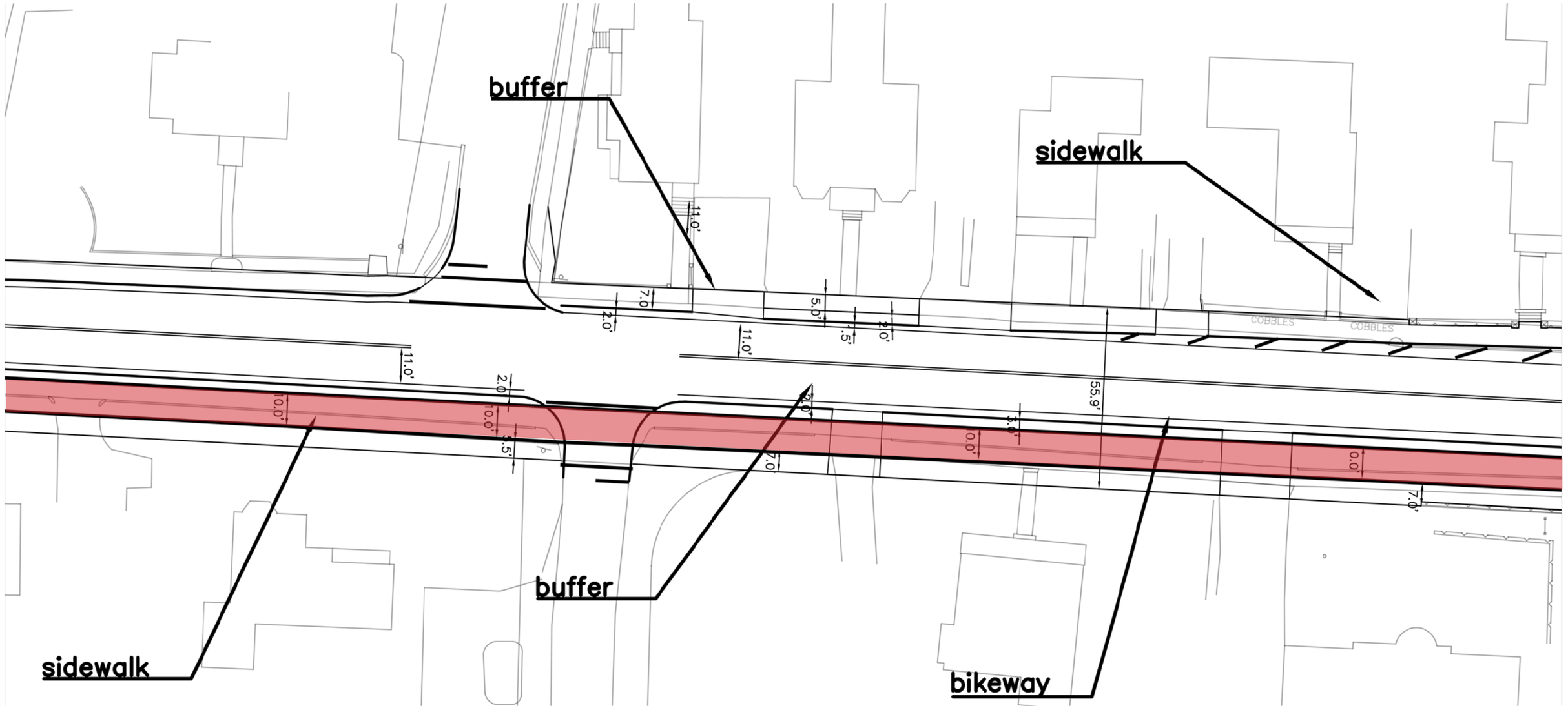

Proposed Two-way Separated Bikeway 3
Scale: 1" = 30'-0"

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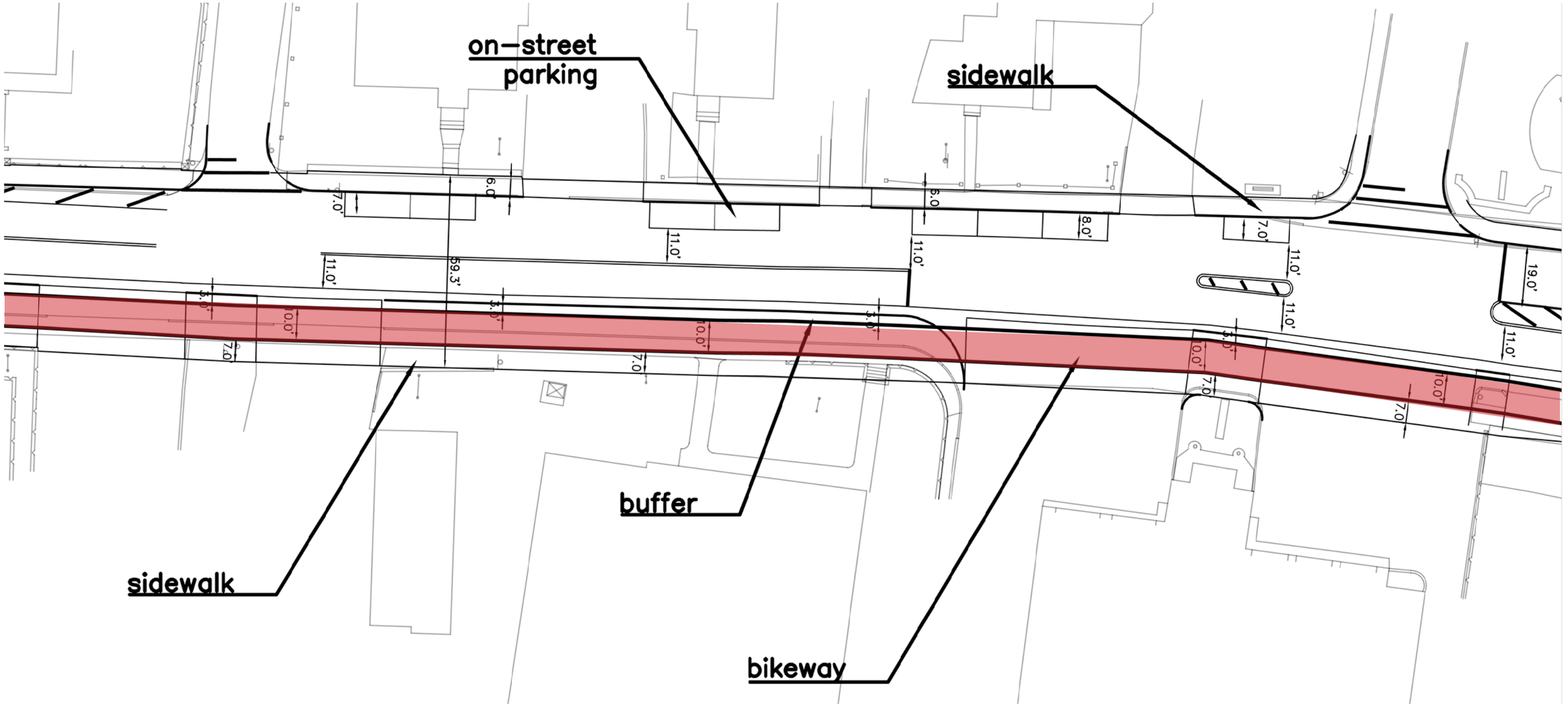

Proposed Two-way Separated Bikeway 4
Scale: 1" = 30'-0"

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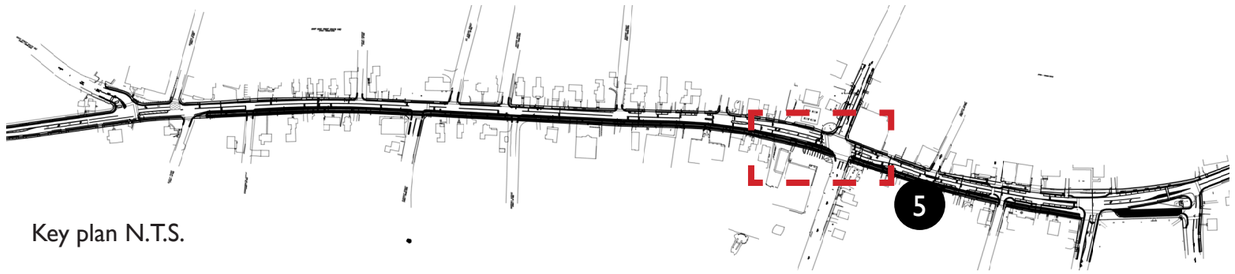

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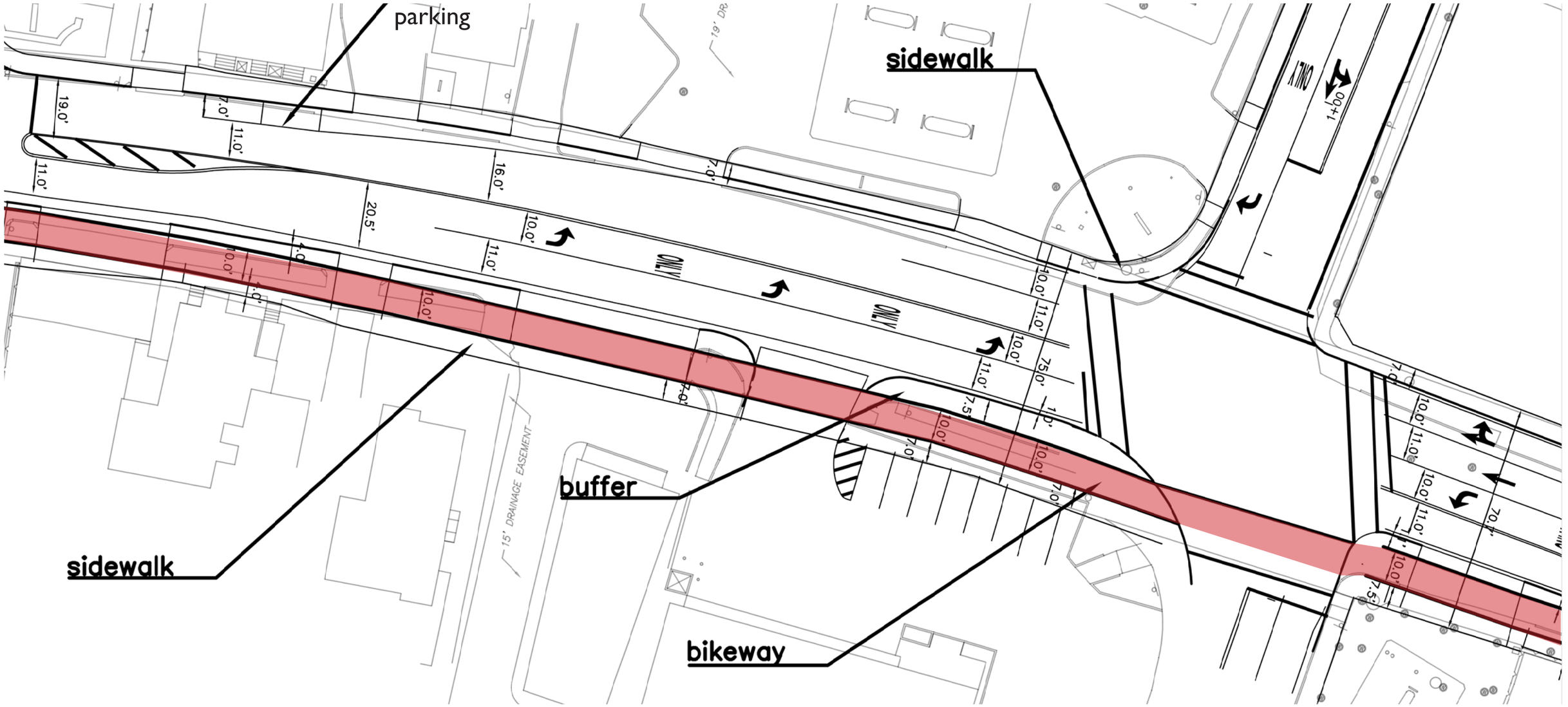

Proposed Two-way Separated Bikeway 5
Scale: 1" = 30'-0"

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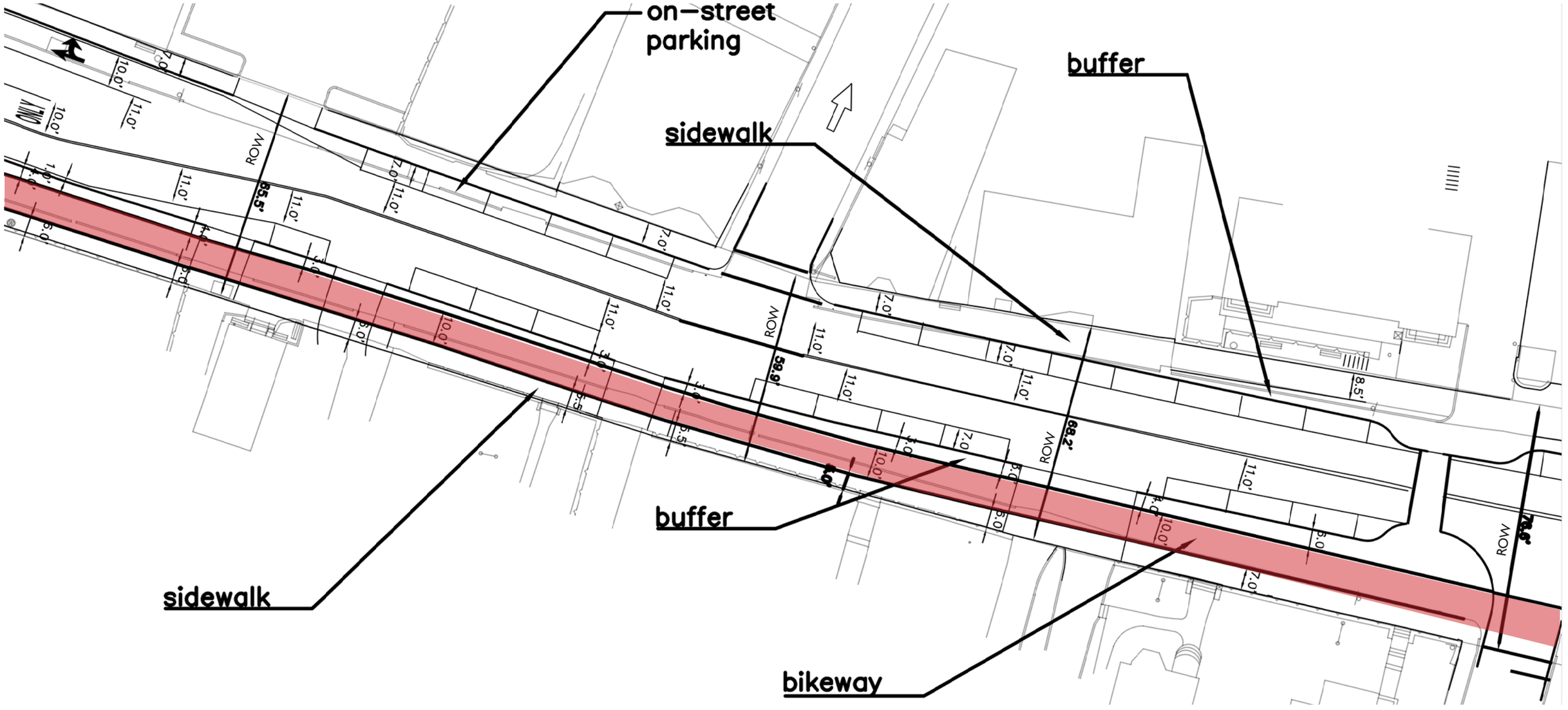

Proposed Two-way Separated Bikeway 6
Scale: 1" = 30'-0"

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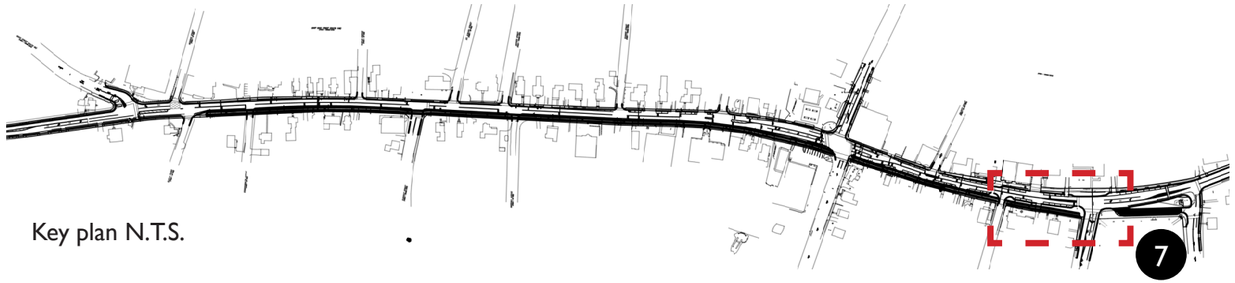

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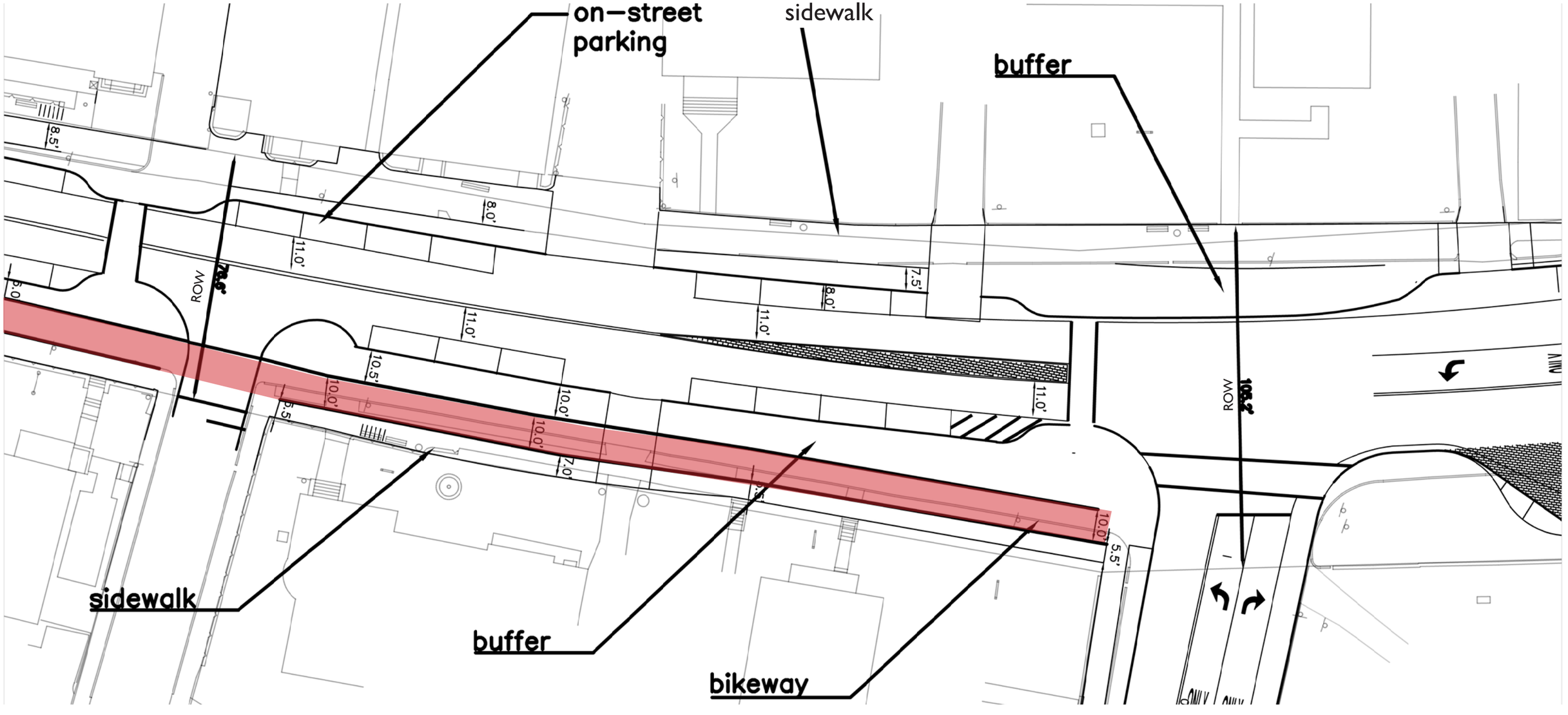

Proposed Two-way Separated Bikeway 7
Scale: 1" = 30'-0"